"Climate change is a driver of global wildfire trends" (WWF)

CLIMATE CHANGE: CHALLENGES & AI-DRIVEN SOLUTIONS

Truyen Tran
A/Professor

A²I² APPLIED ARTIFICIAL INTELLIGENCE INSTITUTE

DEAKIN UNIVERSITY

Photo credit: Tienphong.vn, 09/07/2019

Sir David MacKay

(1967-2016)

Physicist * AI scientist *
Sustainable energy expert *
Cancer fighter

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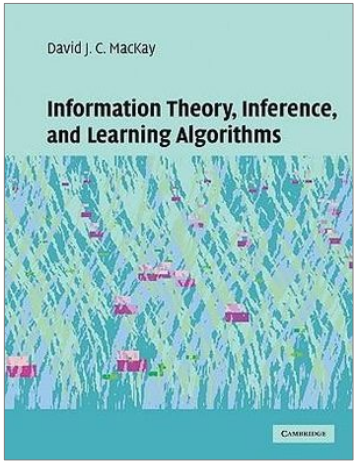
Bayesian methods for adaptive models

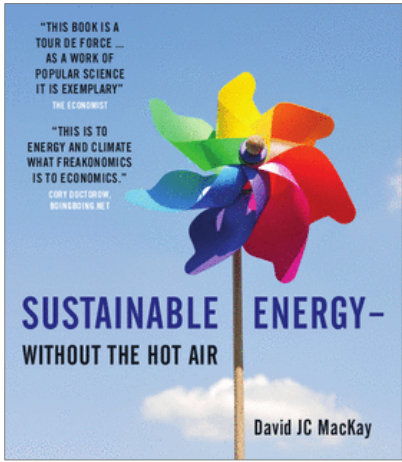
Citation

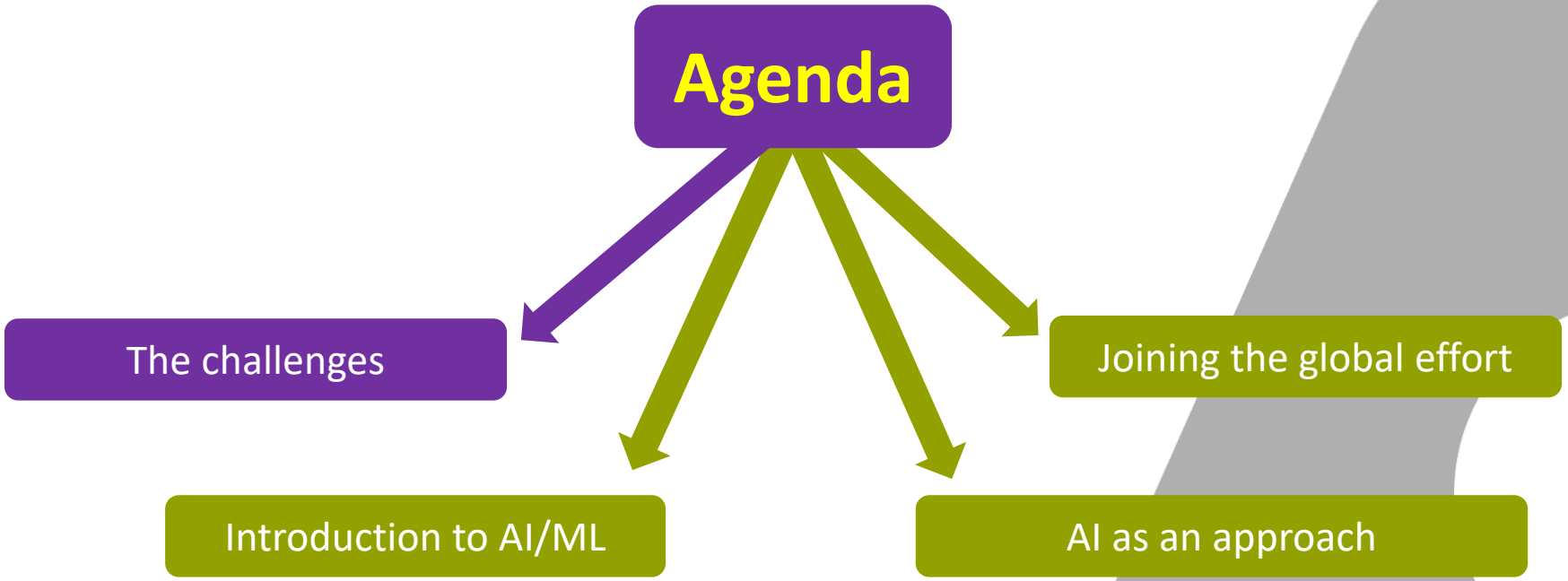
MacKay, David J.C. (1992) *Bayesian methods for adaptive models.* Dissertation (Ph.D.), California Institute of Technology. https://resolver.caltech.edu/CaltechETD:etd-01042007-131447

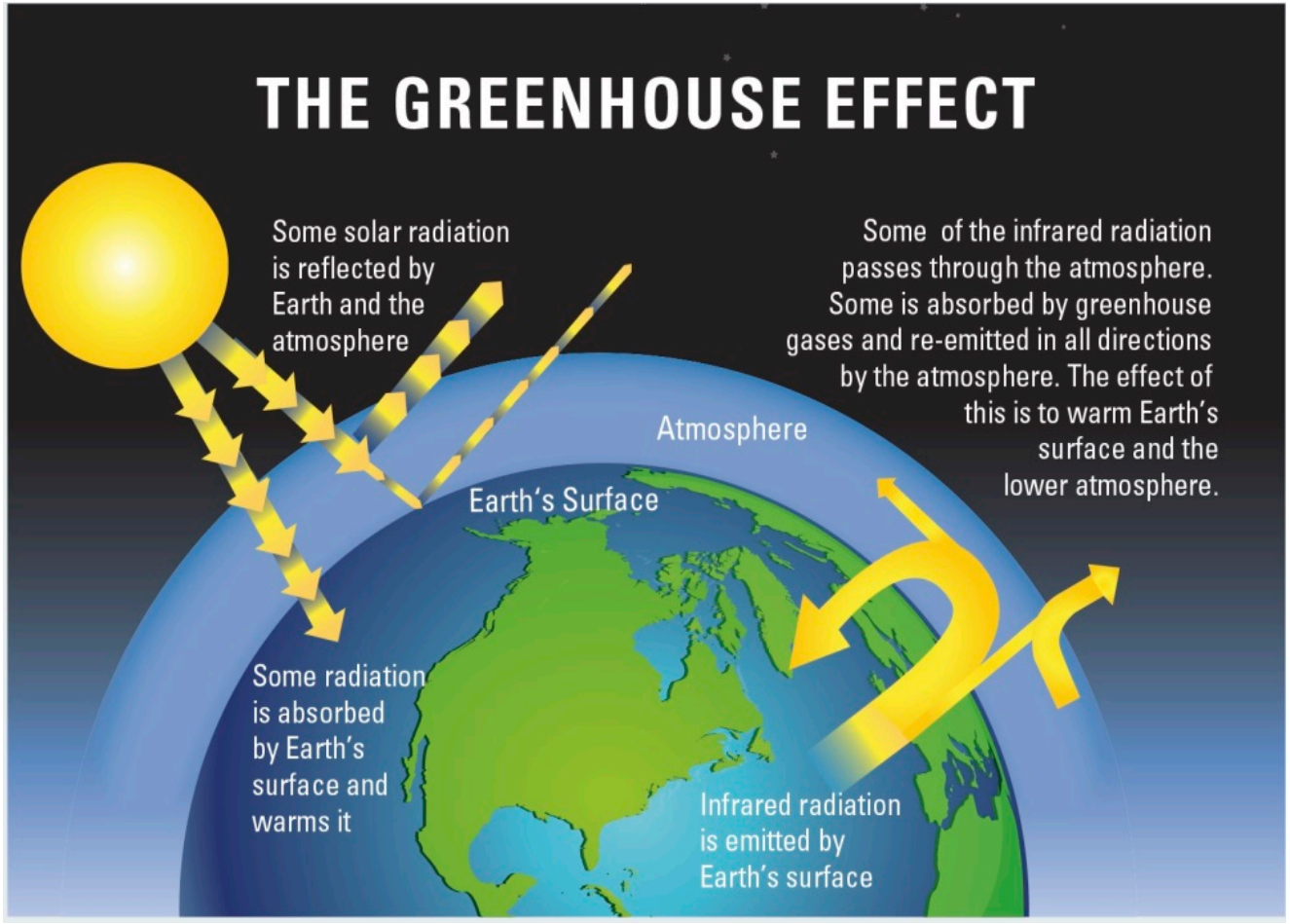
Abstract

The Bayesian framework for model comparison and regularisation is demonstrated by studying interpolation and classification problems modelled with both linear and non-linear models. This framework quantitatively embodies 'Occam's razor'. Over-complex and under-regularised models are automatically inferred to be less probable, even though their flexibility allows them to fit the data better.





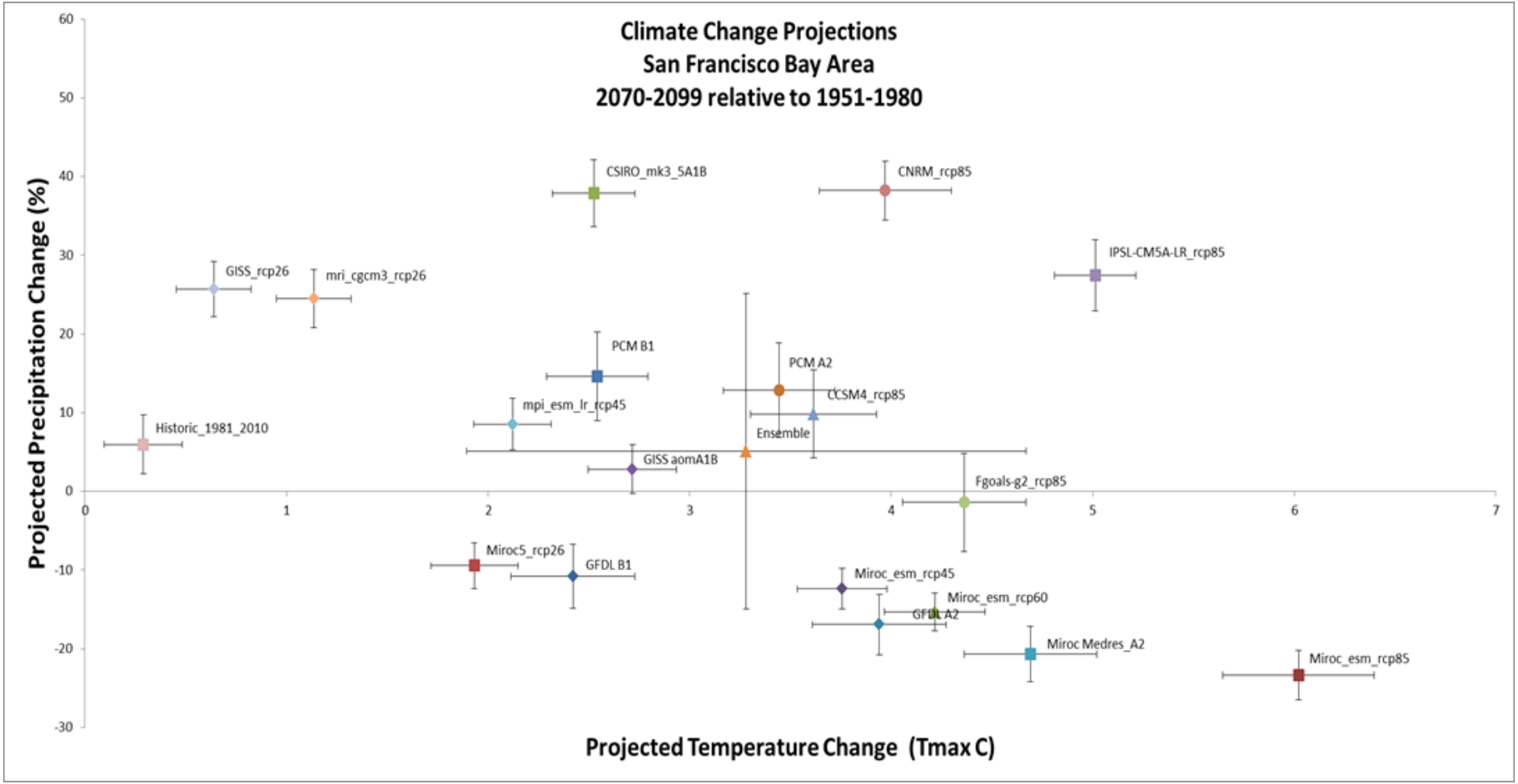

Agenda
The challenges
Introduction to AI/ML
AI as an approach
Joining the global effort



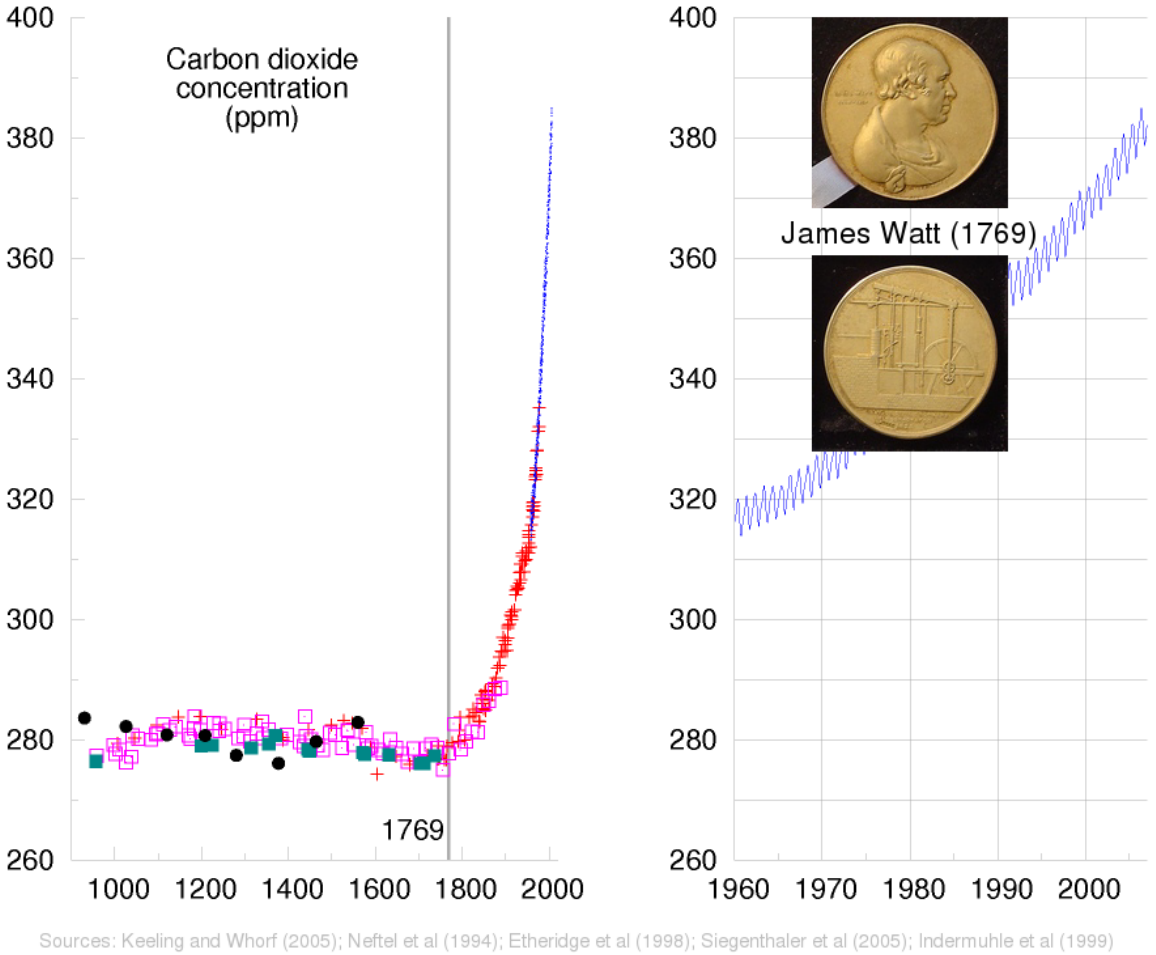
Source: Royal Society

Human greenhouse gas footprints

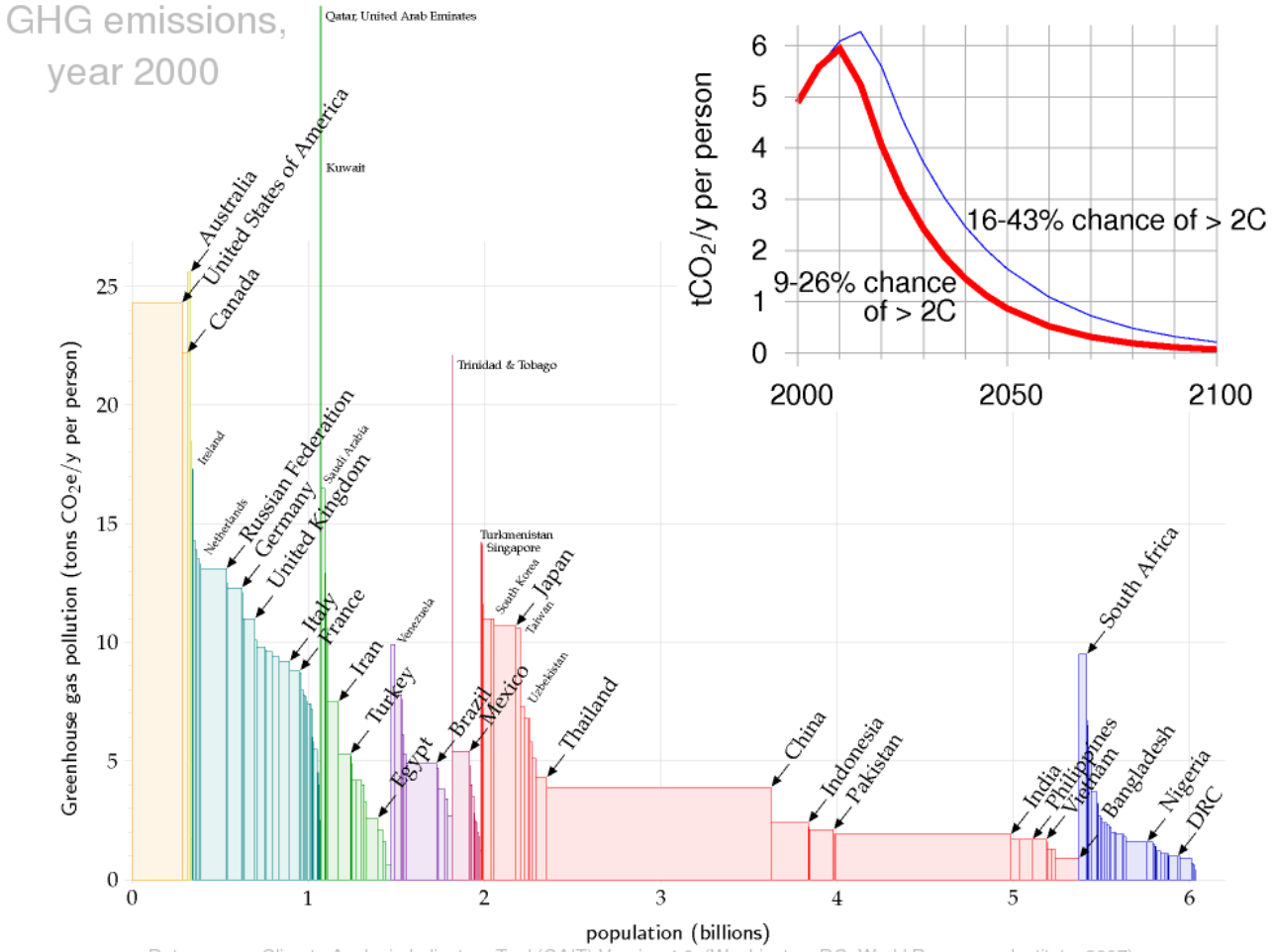
Source: Sceptical Science



Credit: climate calcommons

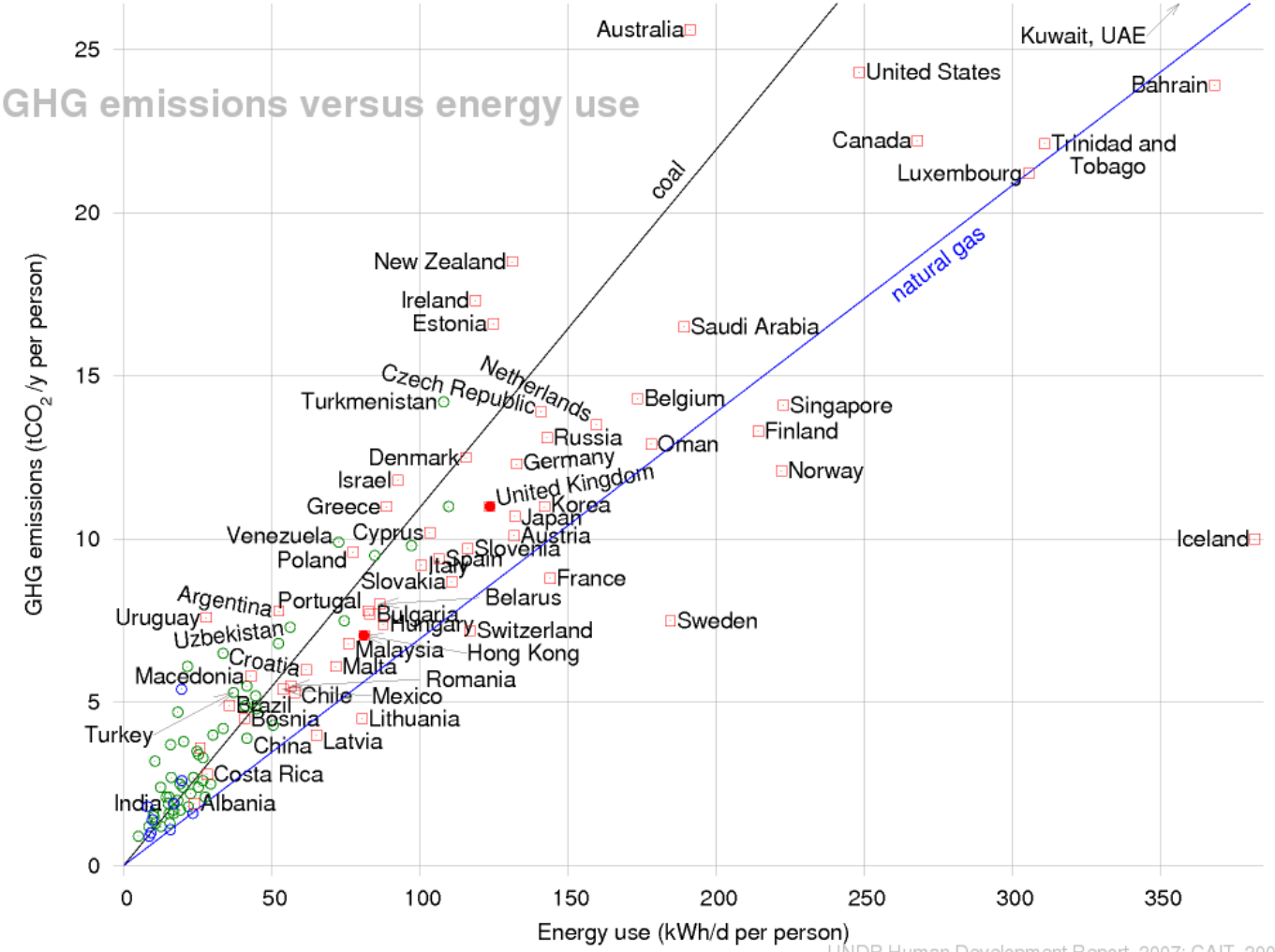


Source: David MacKay, 2007



Data source: Climate Analysis Indicators Tool (CAIT) Version 4.0. (Washington, DC: World Resources Institute, 2007).

Source: David MacKay, 2007



Source: David MacKay, 2007

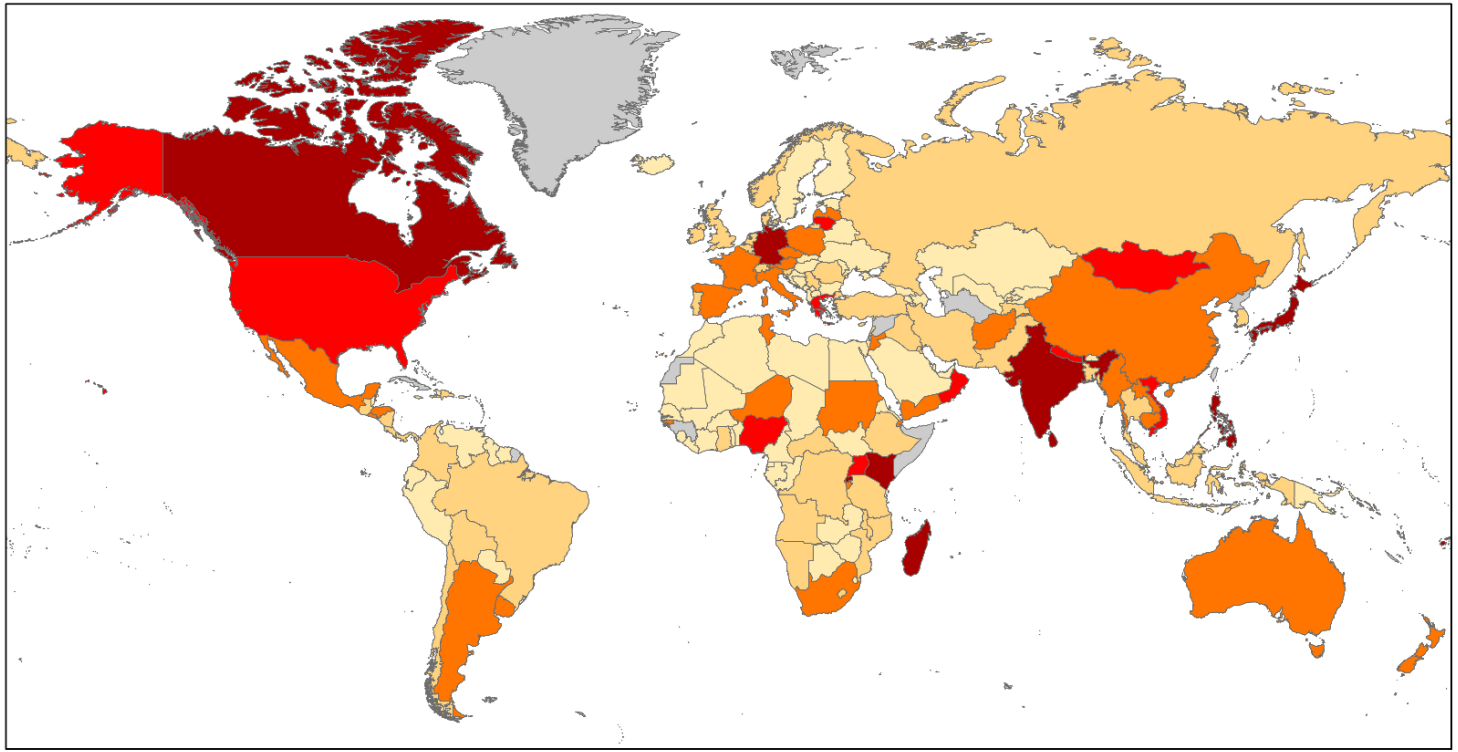
What are the effect?

- large-scale singular events (such as further sea level rise as major ice sheets melt over Greenland and Antarctica)
- threatening the survival of certain ecosystems
- exacerbating extreme weather events (e.g. heat waves, drought, extreme rainfall, and coastal flooding)
- altering sea ice concentrations, river flow and coastal erosion
- pushing plant and animal species towards the poles and to higher elevations
- slowing productivity gains for some crops such as wheat and maize
- severe impacts on the world's poorest and most vulnerable populations

Source: The Committee on Climate Change, UK

GERMANWATCH

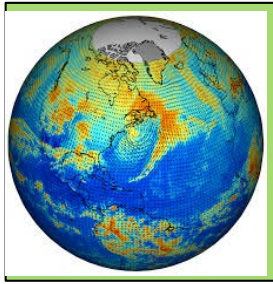
Climate Risk Index 2020



www.germanwatch.org/en/cri

Hà Tĩnh, 09/07/2019 – Tiền Phong

What can we/AI do?



Advancing climate sciences

- Data-driven climate models
- Process-based climate models
- Hybrid-models

Reduction

- Energy
- Industry
- Buildings & cities
- Farms & forests
- Transportation

Adaptation

- Disaster prevention
- Societal impact
- Ecological impact

Alteration

- Sequestration
- Geoengineering

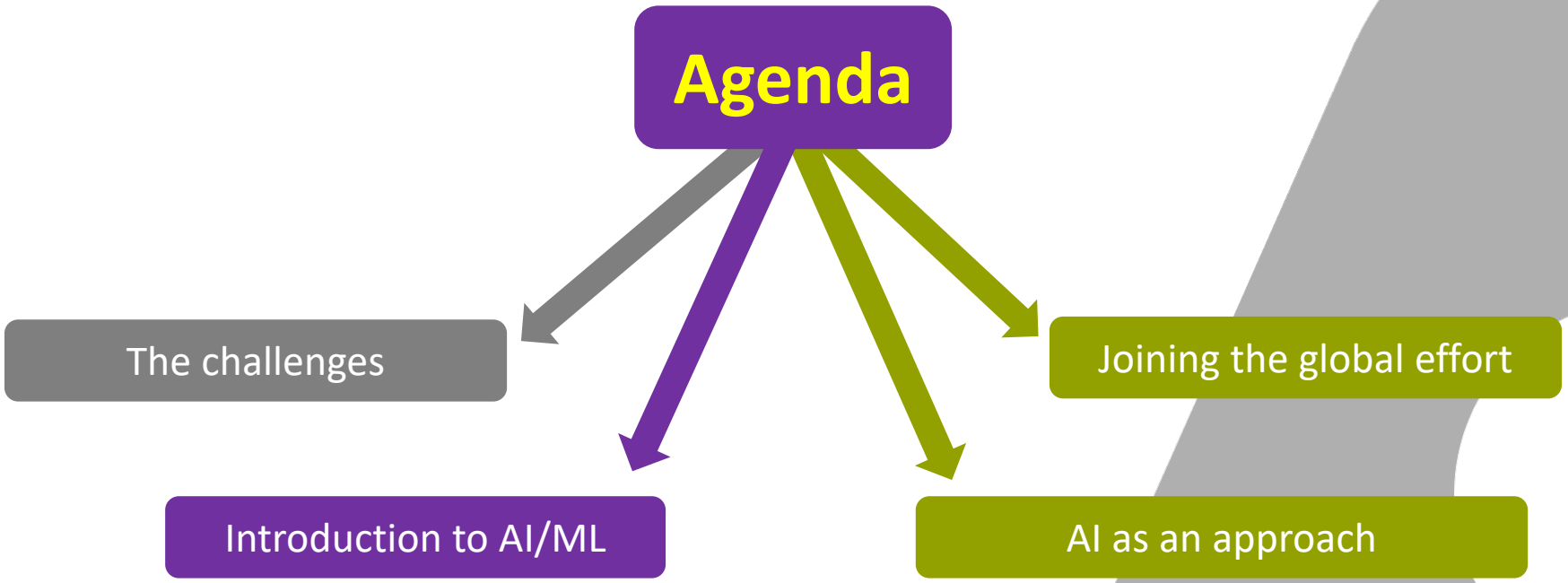
Education

- Raise awareness | Enable individual actions

Adapted from Ng & Zhou 2019

Photo credit: bedford

Agenda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What is AI?

Among the most challenging scientific questions of our time are the corresponding analytic and synthetic problems:

- How does the brain function?
- Can we design a machine which will simulate a brain?

-- *Automata Studies*, 1956.

What makes AI?

Perceiving

Learning

Reasoning

Planning

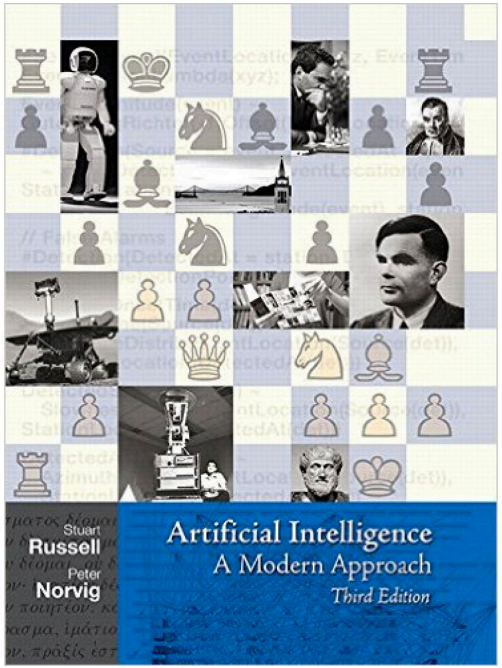
Acting

Robotics

Communicating

Consciousness

Automated discovery



Modern AI is mostly data-driven, as opposed to classic AI, which is mostly expert-driven.

Narrow AI (rule-based, speech)

Personalization: 76,897 Micro-genres

Rule-based decisions

Industrial robots

Narrow AI – with big data (B-2-C, search, ecommerce)

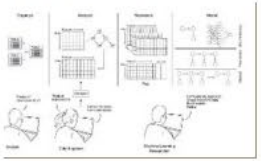
Deep learning – image processing

Handwriting & voice recognition

NLP & big data statistical learning

Democratisation & embodied AI

Data scientist in a box



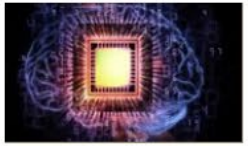
Home & service robots

Self-driving vehicles

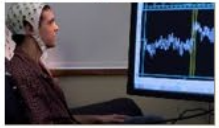
Collaborative AI on new AI hardware

Man-machine collaboration

Neuromorphic computing

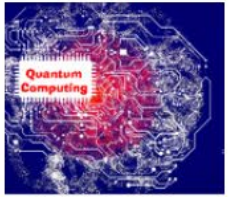


Brain-computer interfaces



Artificial general intelligence

Quantum computing



Emotional robots

Past | 90's | 00's | Now | Next 5 years | Next 20 years | Future

Source: PwC

Machine learning

(system that improves its performance with more experience)

Supervised learning

(mostly machine)

A → B

Will be quickly solved for "easy" problems (Andrew Ng)

Unsupervised learning

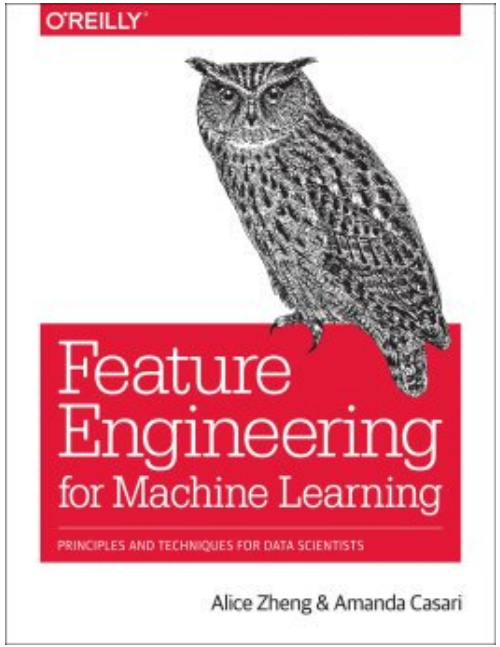
(mostly human)

$$\mathbf{v} \sim P_{model}(\mathbf{v})$$
$$P_{model}(\mathbf{v}) \approx P_{data}(\mathbf{v})$$

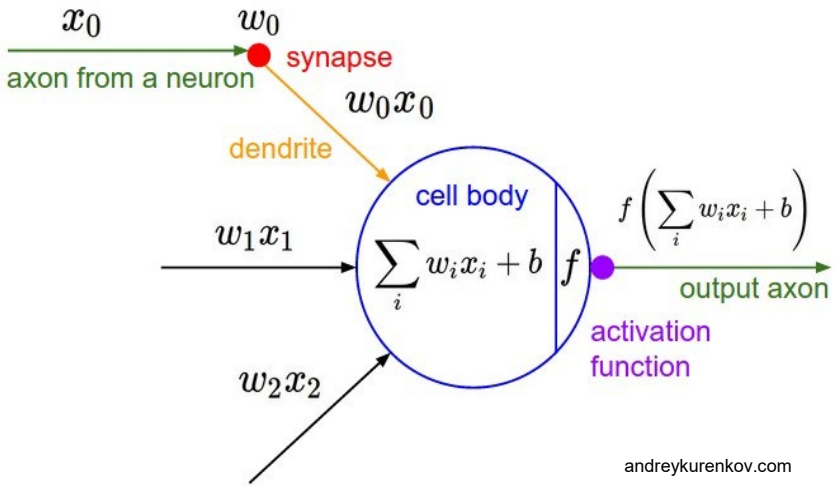
Anywhere in between: semi-supervised learning, reinforcement learning, lifelong learning, meta-learning, few-shot learning, knowledge-based ML

ML starts with feature ~~engineering~~ learning

- In typical machine learning projects, 80-90% effort is on feature engineering
- **E.g., flood prediction**: history, current weather, deforestation rate, change in landscape, construction density, etc.
- A range of powerful classifiers: Random forests, GBM, SVM, deep neural nets, etc.
- Try yourself on Kaggle.com!

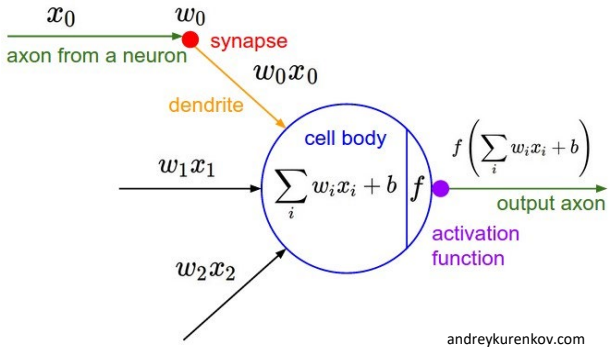


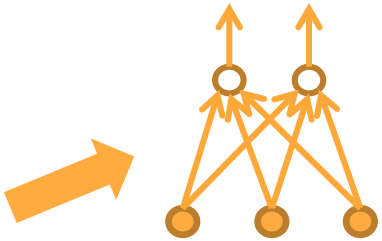
Current AI (deep learning): Mimic the brain



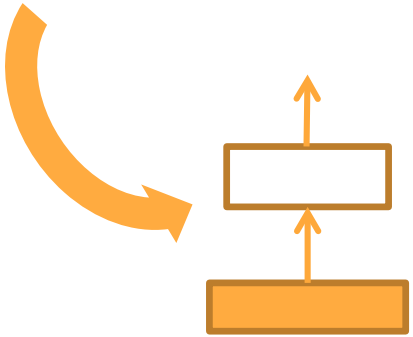
DL basic 1: Repeat the trick, horizontally and vertically

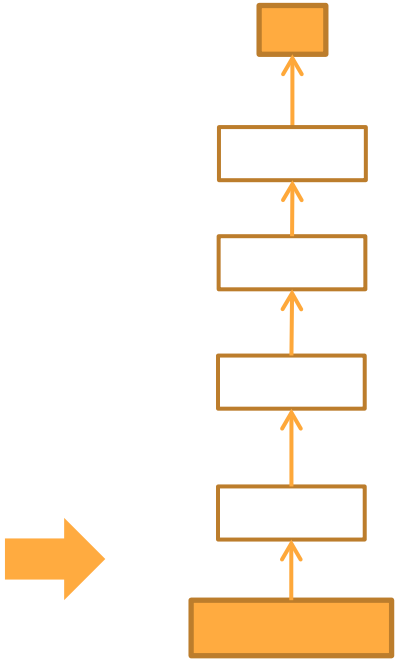
Integrate-and-fire neuron





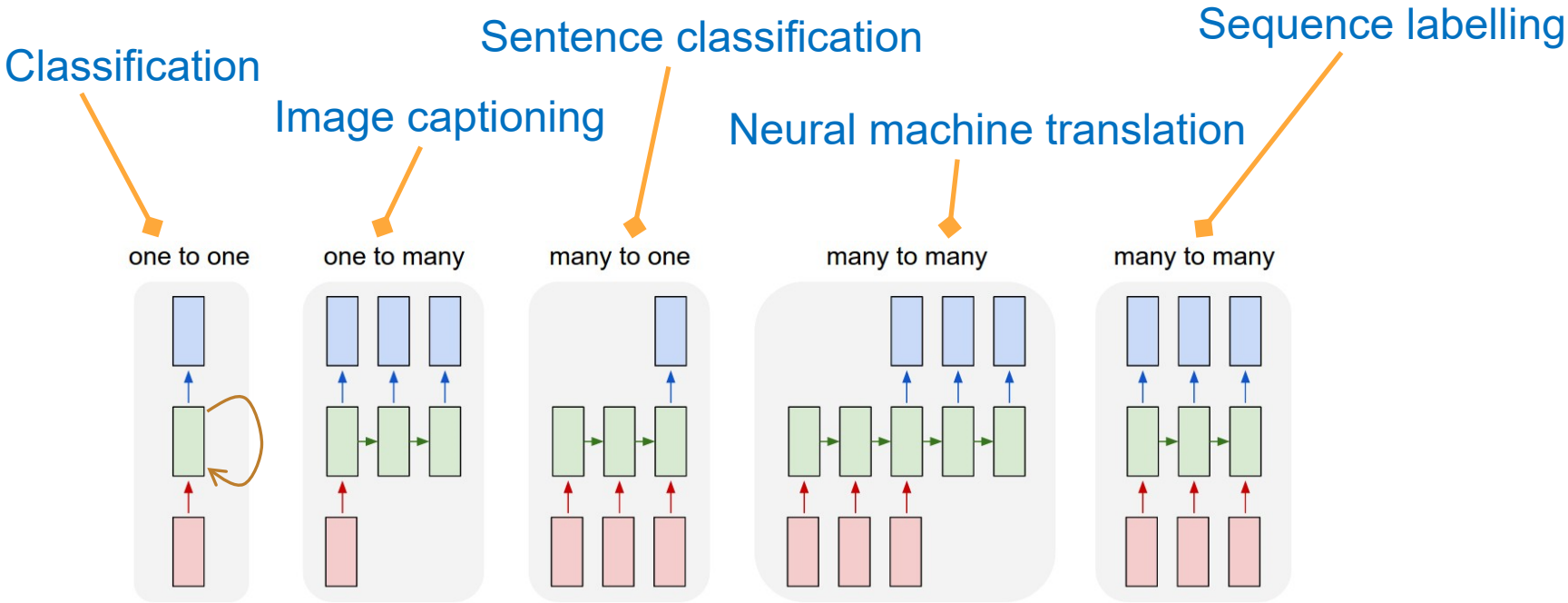
Feature detector





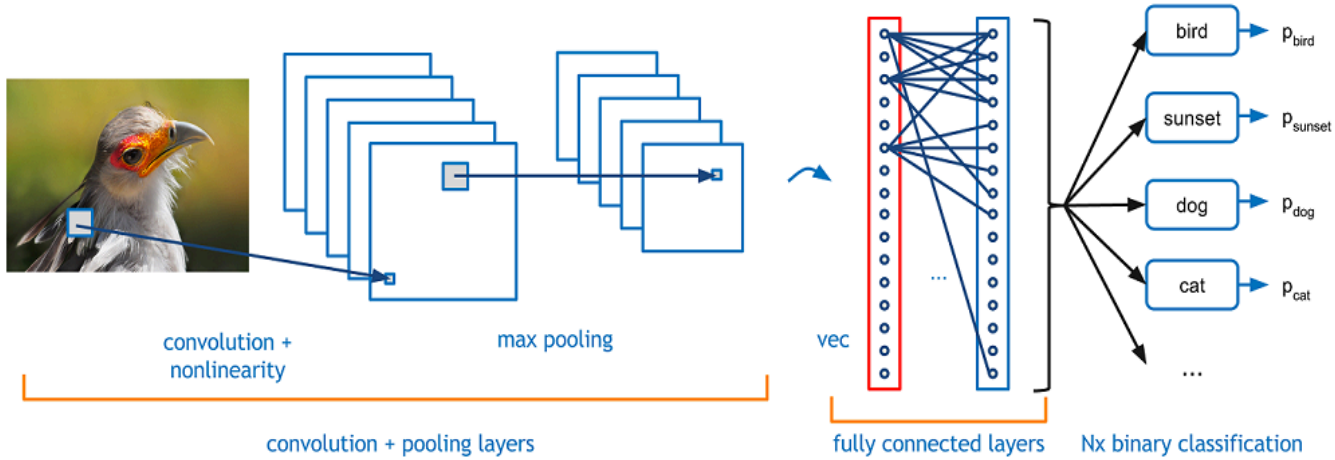
Block representation

DL basic 2: Keep looking ahead



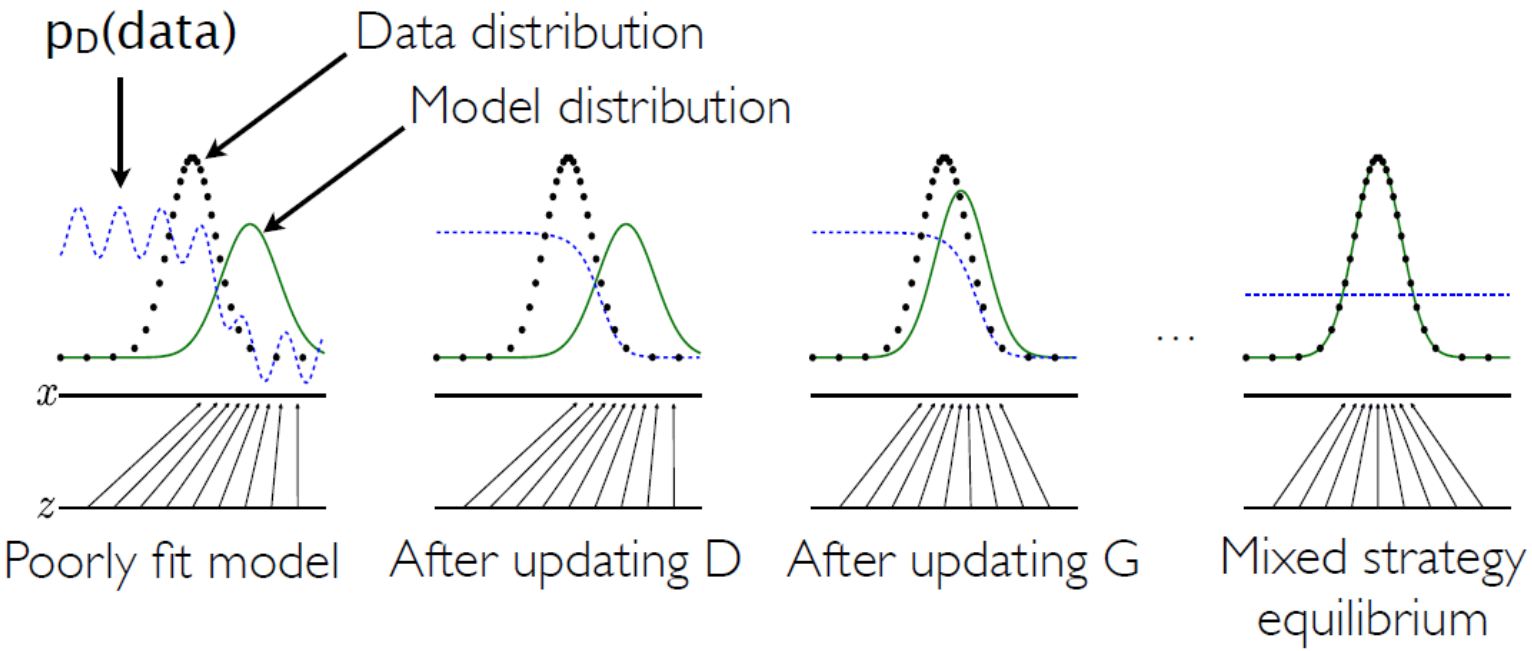
Source: karpathy

DL basic 3: Repeat and vote



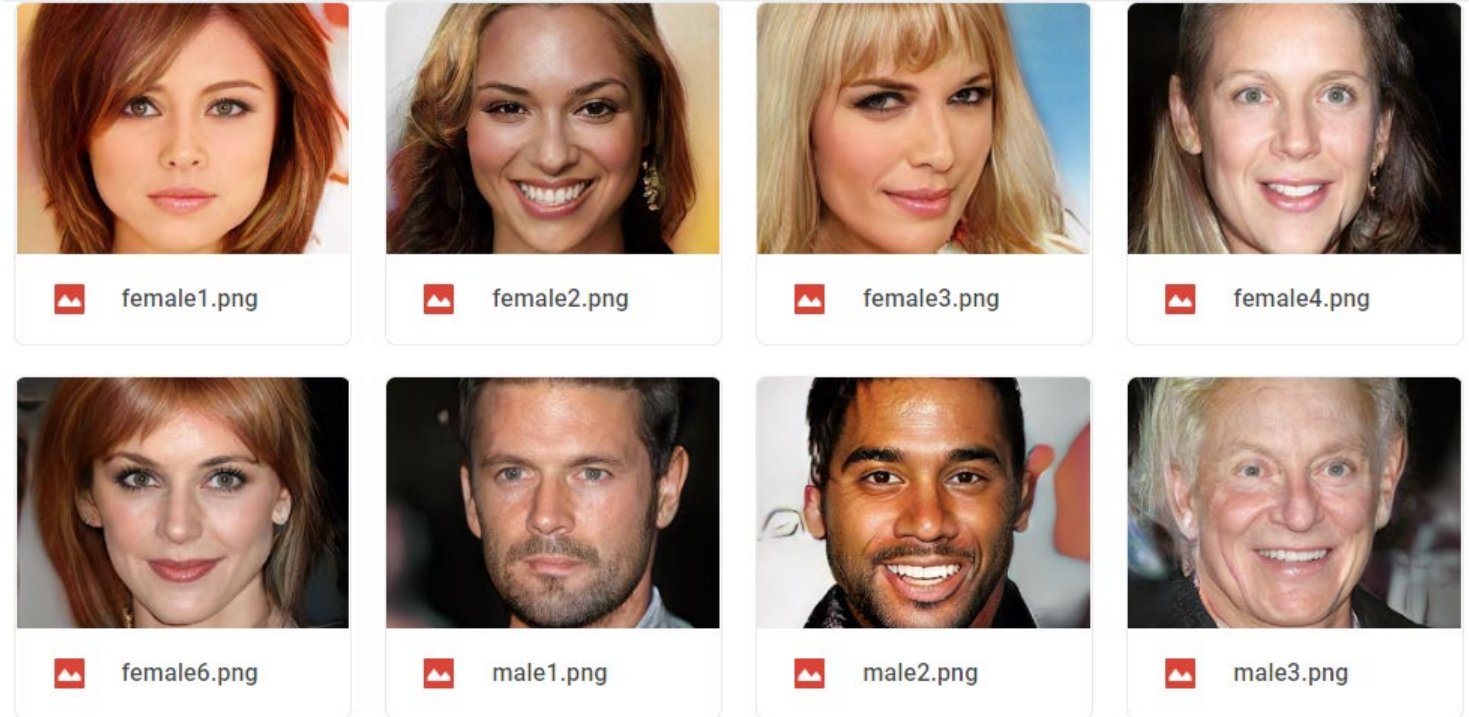
Source: adeshpande3

DL basic 4: Dual - guess and judge



Adapted from Goodfellow's, NIPS 2014

Can you tell which one is real?



Karras, T., Aila, T., Laine, S., & Lehtinen, J. (2017). Progressive growing of gans for improved quality, stability, and variation. *arXiv preprint arXiv:1710.10196*.

What can AI/ML do, as a **General Purpose Tech**?

Predict, aka slot filling

Optimize, aka finding better places.

Uncover hidden factors & clusters

Detect complex relationships

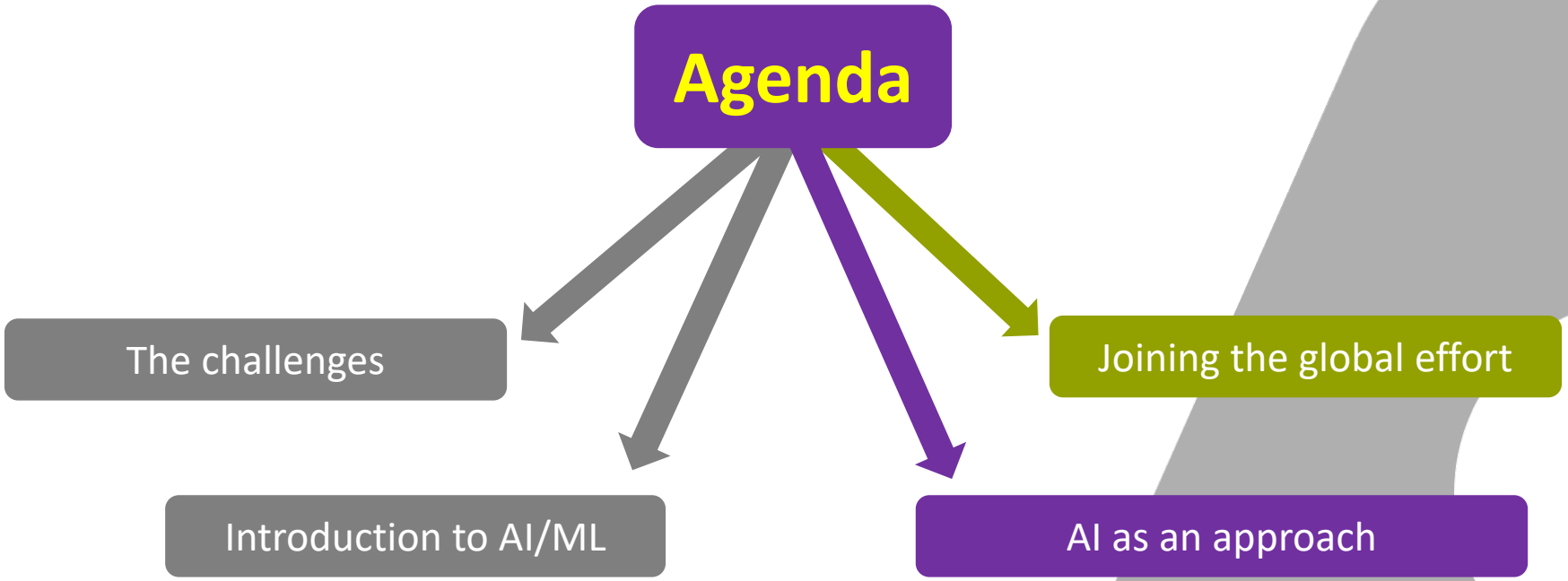
Mimic the world

Suggest actions with long-term rewards

Reason about the world

Be aware of its own limitations

[shutterstock: 567338095, Sarah Holmlund]. Credit: e3zine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One upon a time … in movies

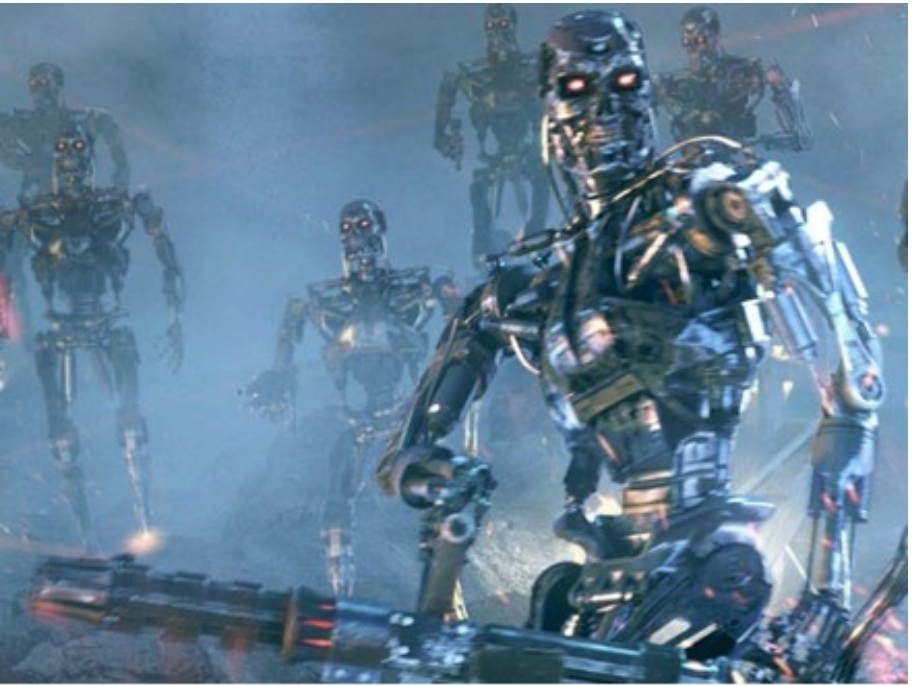


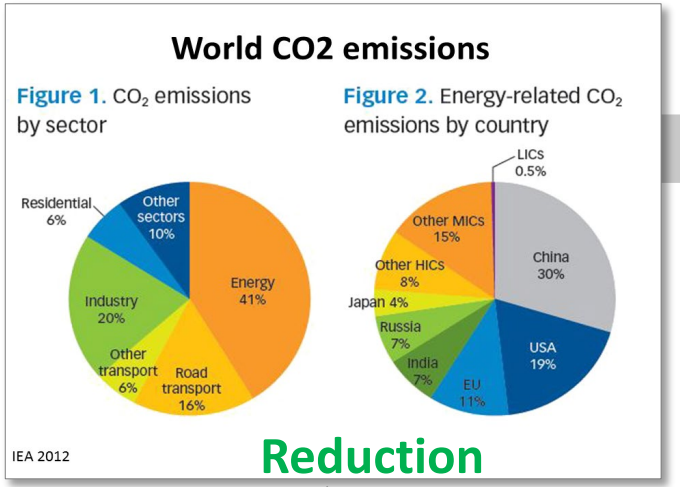
Image: © EPA PHOTO/EFE/Columbia TriStar/Robert Zucker

Hate

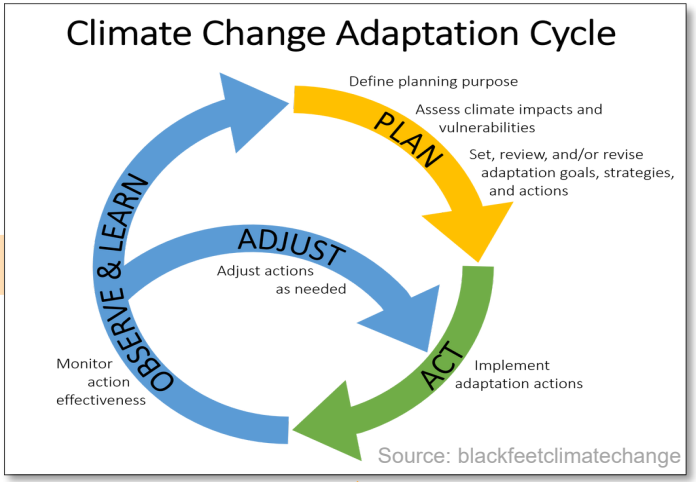
Source: opgal

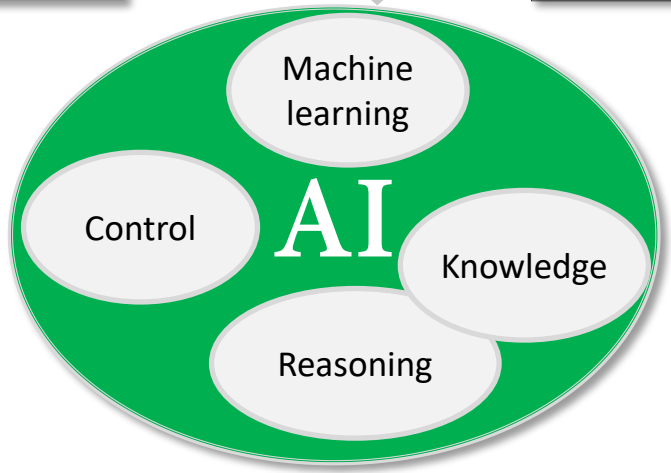
Love

Right now, on planet Earth



Reduction



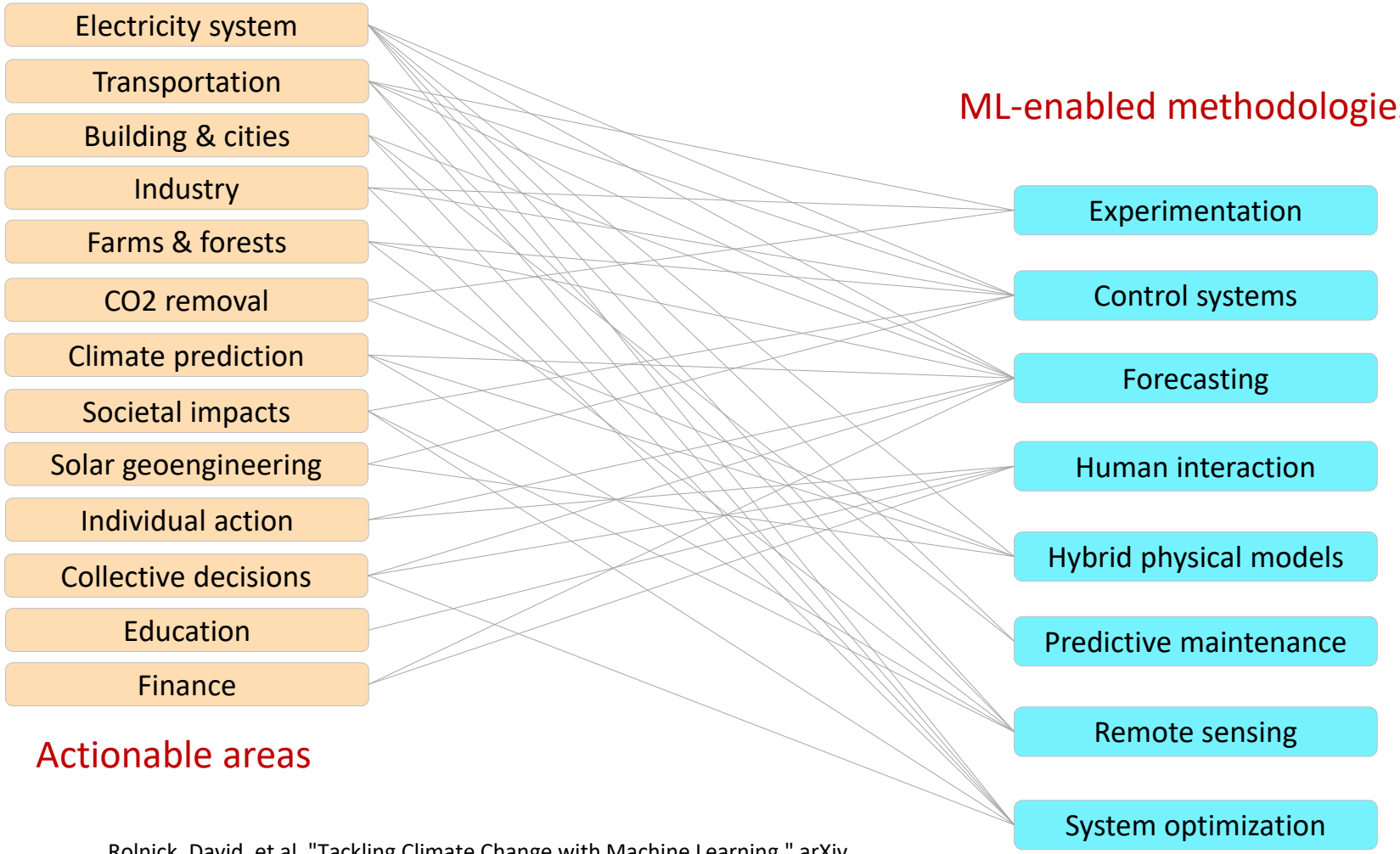


What can AI/ML do to tackle climate change?

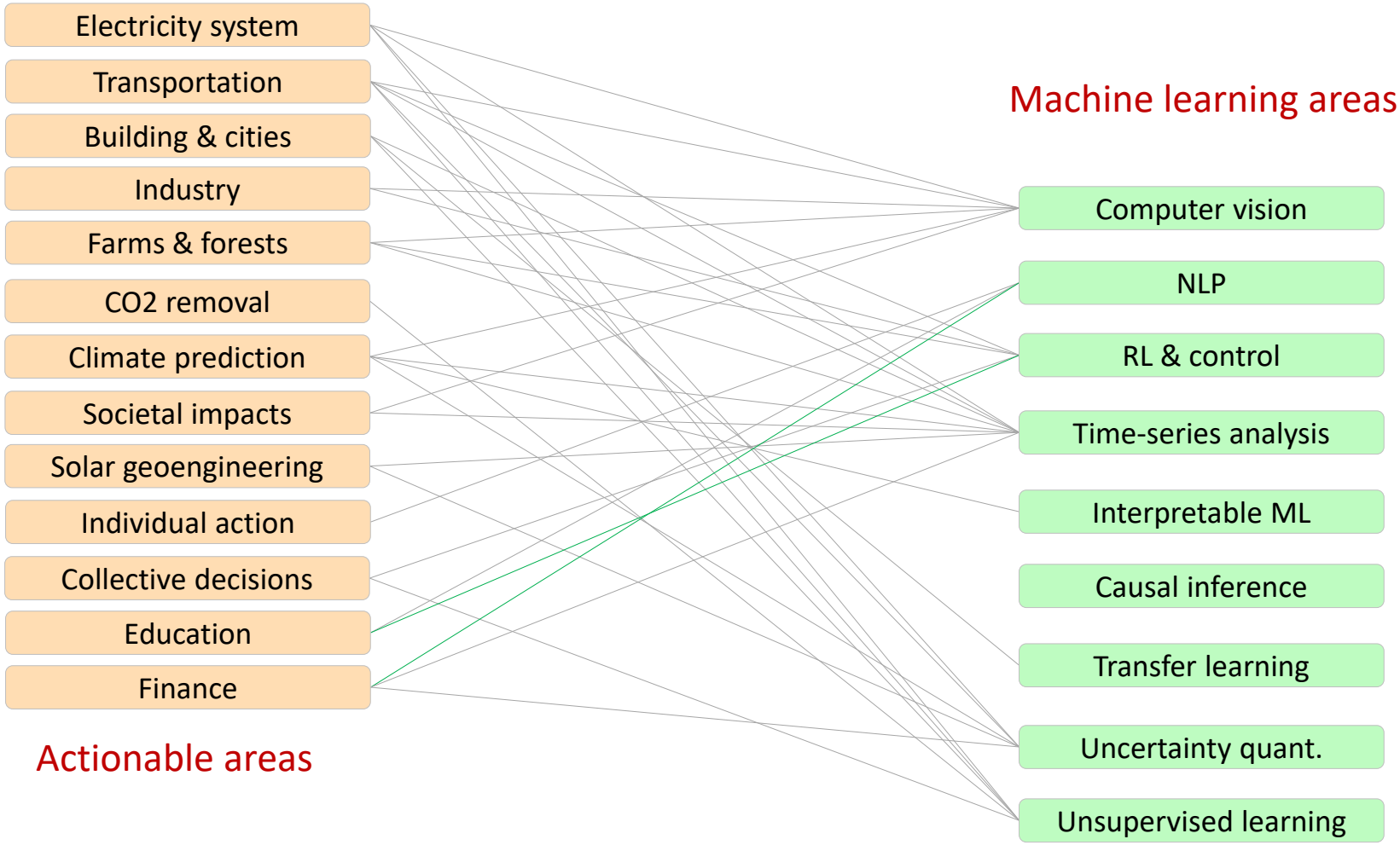
- Make systems more efficient
- Enable remote sensing and automatic monitoring
- Provide fast approximations to time intensive simulations
- Support interpretable or causal models (e.g. for understanding weather patterns, informing policy makers, and planning for disasters).

AI/ML is only one part of the solution!

- It is a tool that enables other tools across fields
- Its performance improves with more data!

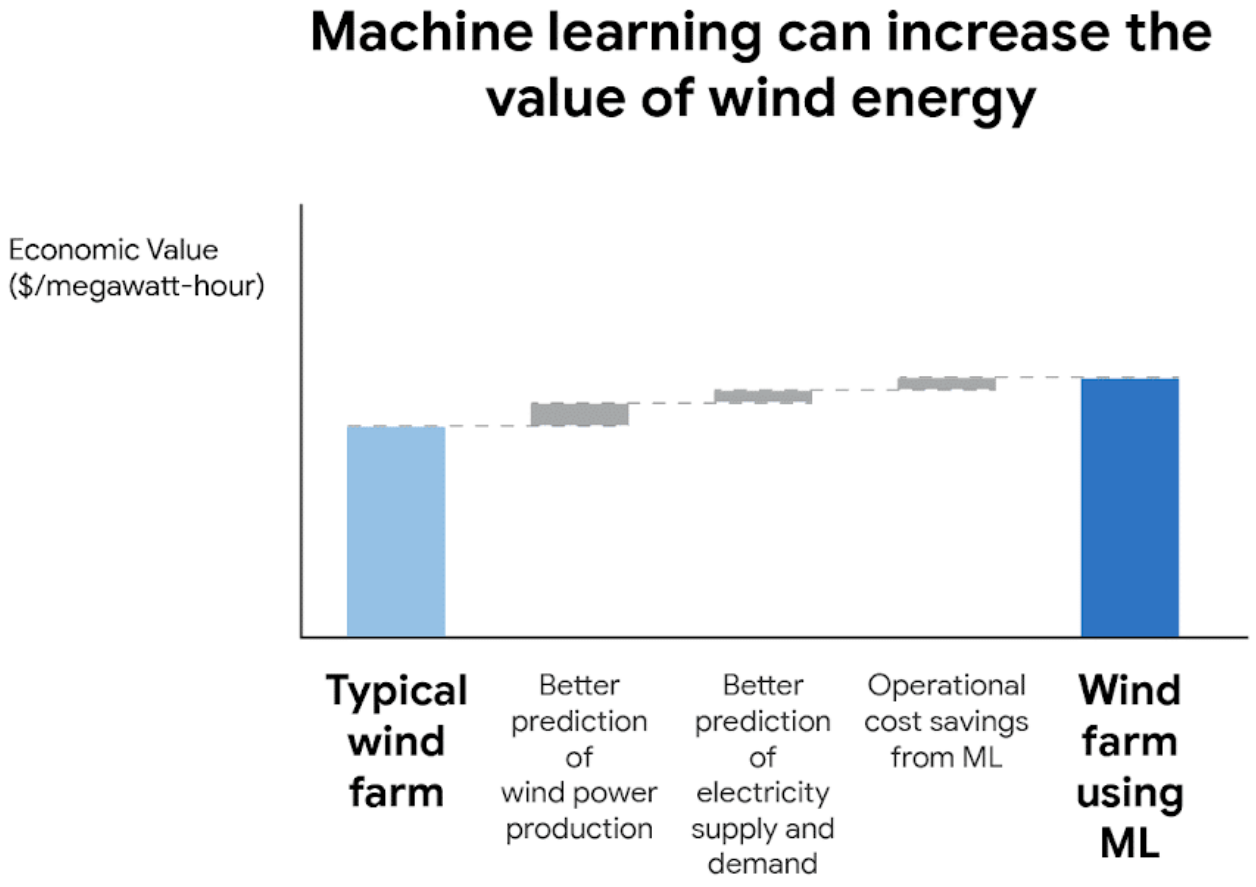


Rolnick, David, et al. "Tackling Climate Change with Machine Learning." arXiv preprint arXiv:1906.05433 (2019).



Rolnick, David, et al. "Tackling Climate Change with Machine Learning." arXiv preprint arXiv:1906.05433 (2019).

Energy



Source: financial-news-now

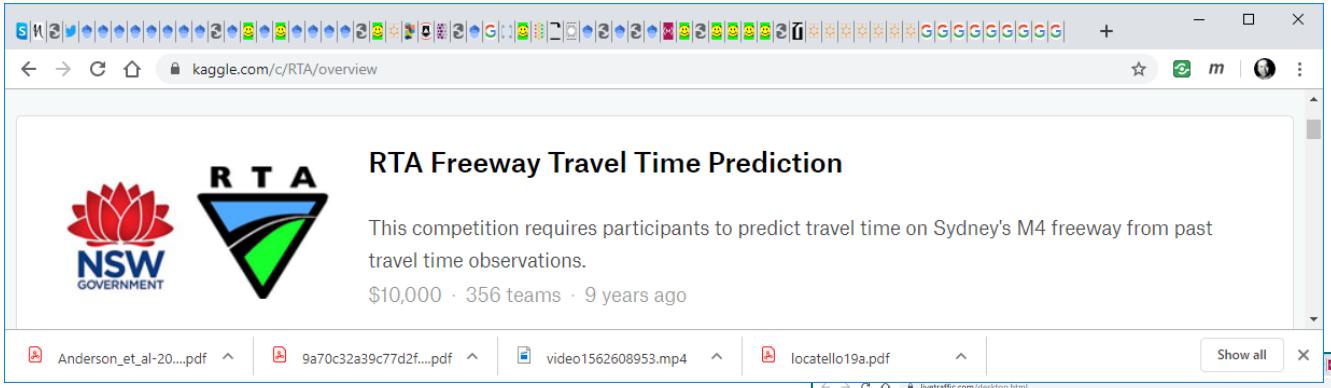
Transportation

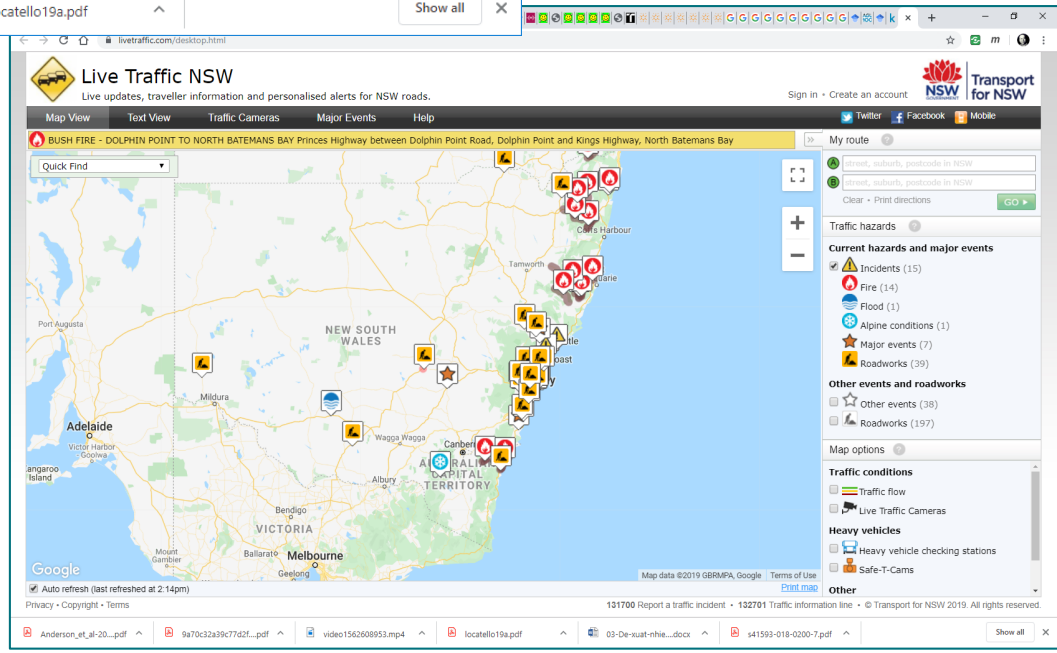
Problems

- Increased CO2 footprint
- Lost of time
- Health issues (physical and mental)
- Lost of productivity
- Increase transportation cost

AI/ML-driven solutions

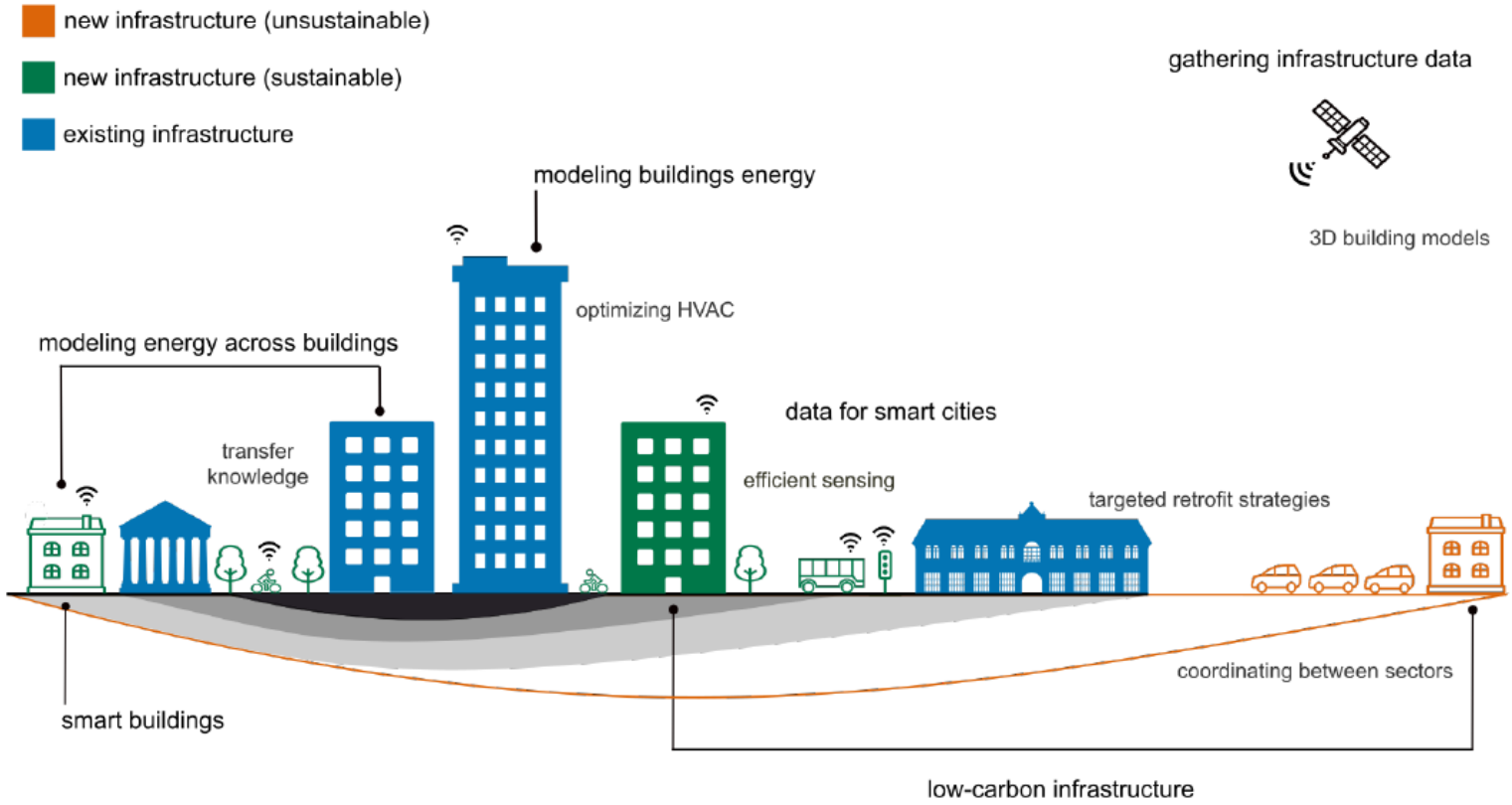
- Predict traffic congestion, suggest alternative route
- Optimize fuel consumption
- Detect route/traffic management maintenance





"Forecasting travel times helps improve road safety and efficiency. Accurate predictions help commuters make informed decisions about when to travel and on what routes. This helps to lower intensity on problem arterials by encouraging motorists to use underutilised parts of the grid, and where possible, by having them select alternative times and modes of travel."

Smart homes and cities



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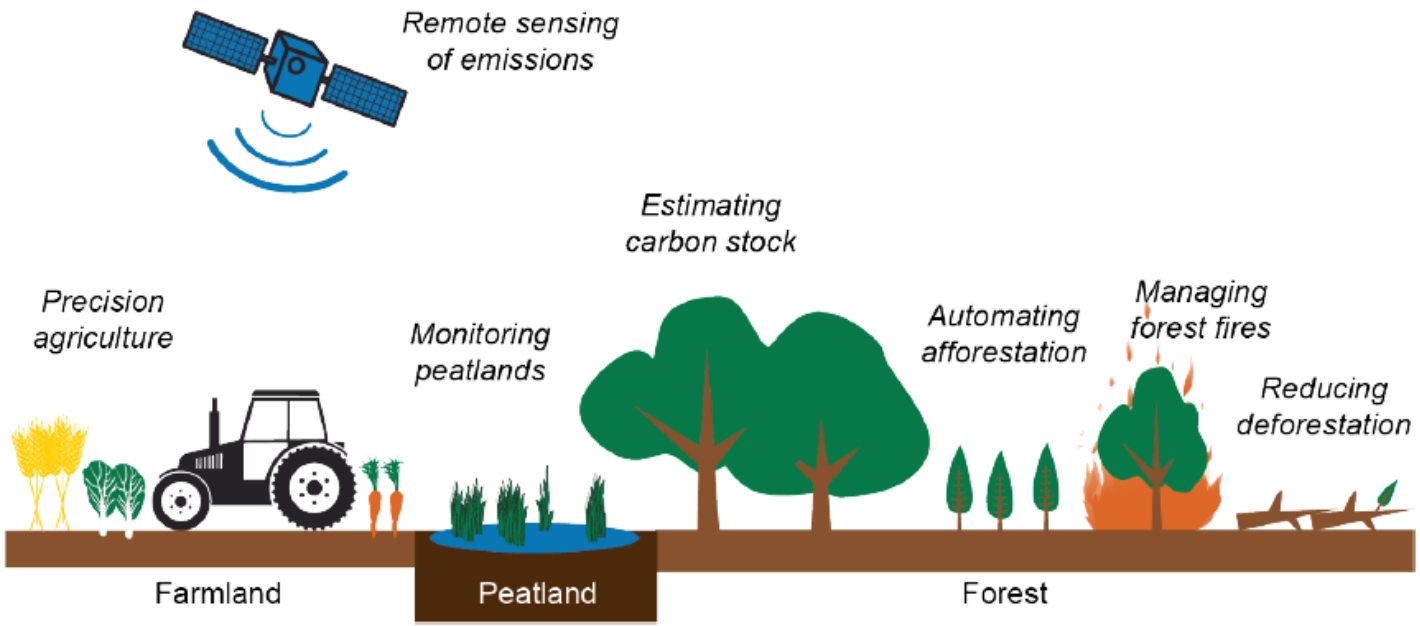
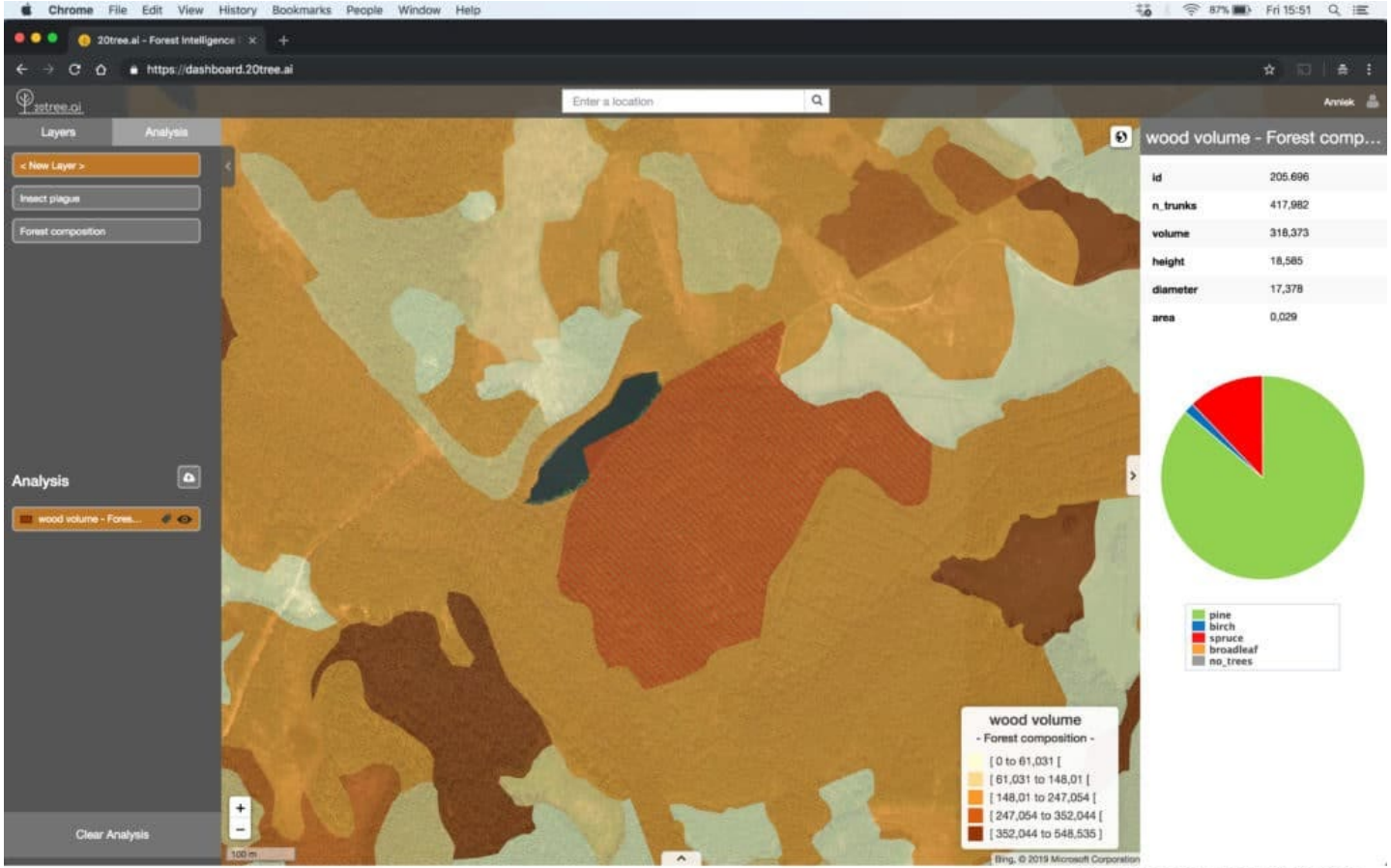
Farms and forests

- Sensor network, automated sensing and optimization



20tree.ai surveys and maps forests.



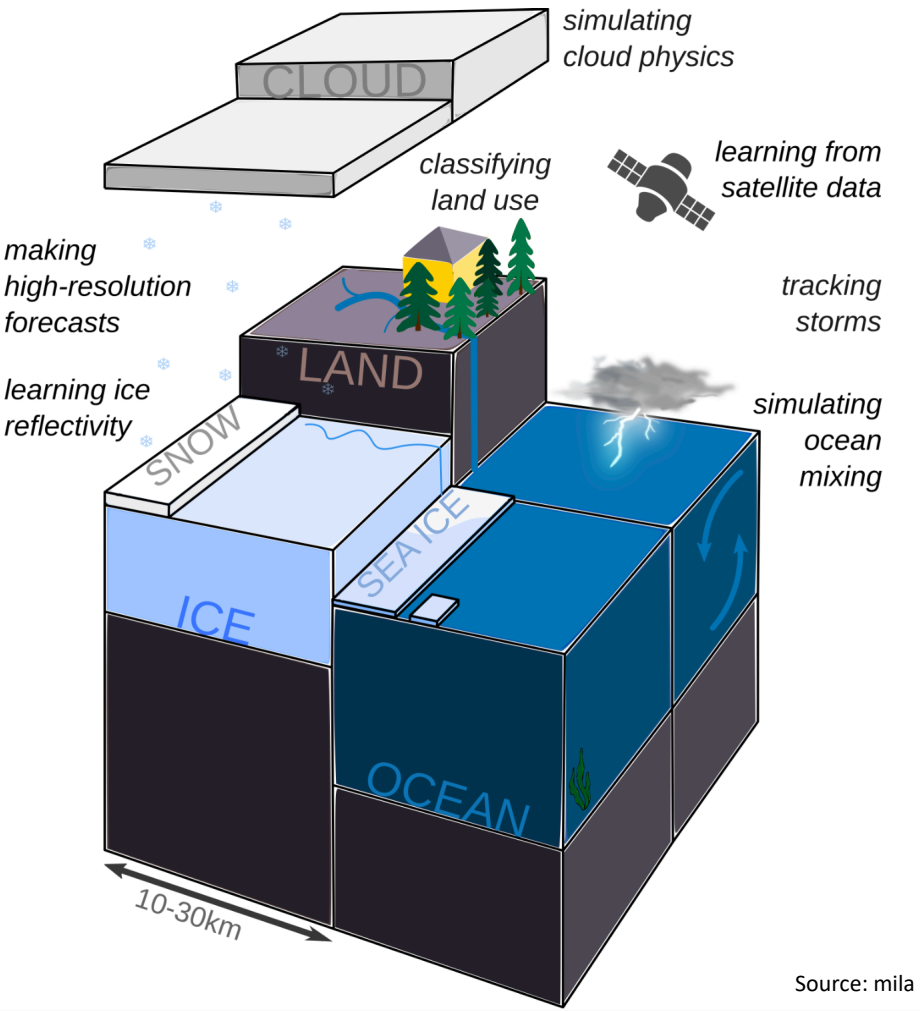
From: Financial News Now

Image source: blogs.nvidia.com

Collecting information underwater

Climate prediction

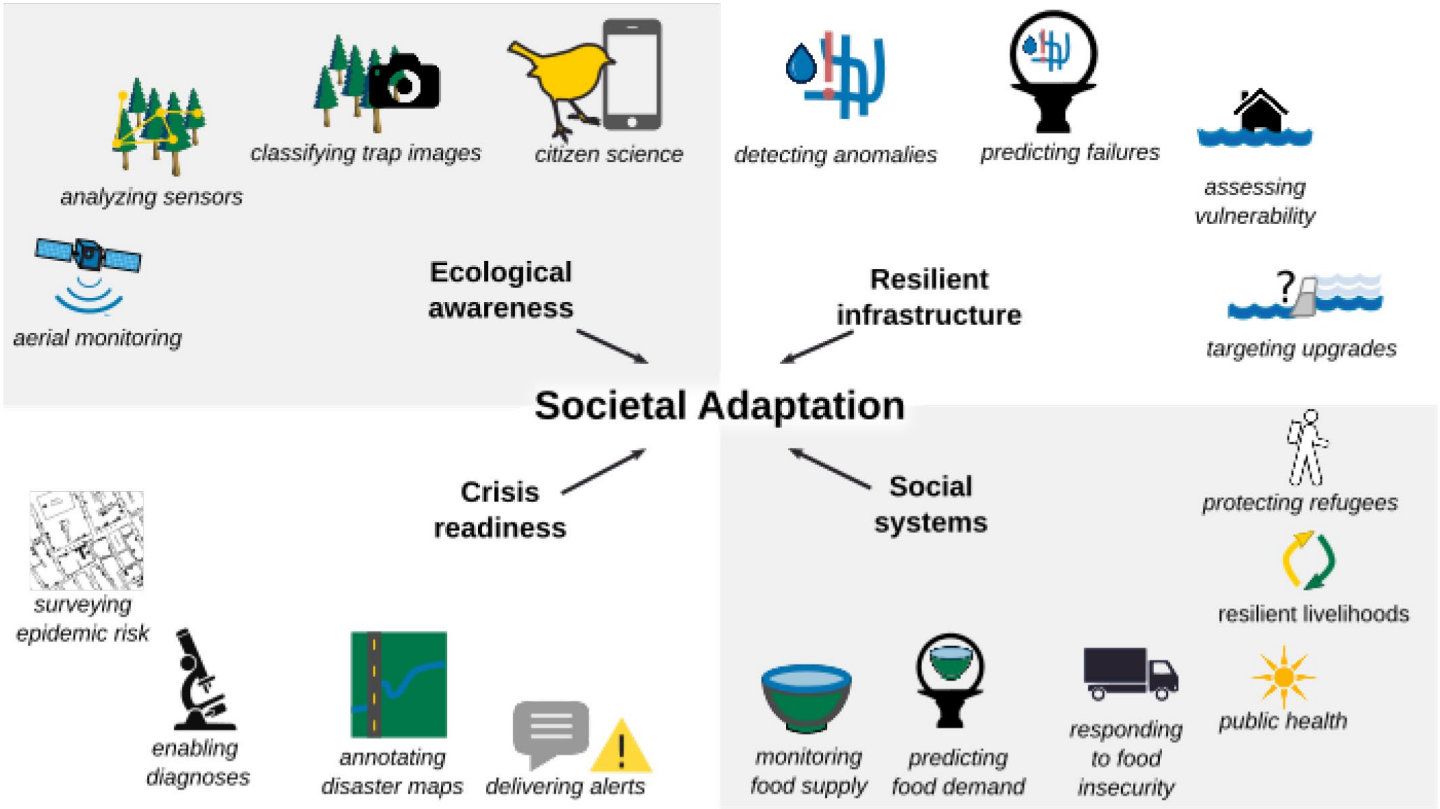
- Predict effects of climate change
- Extremely fast approximation alternative to complex simulation

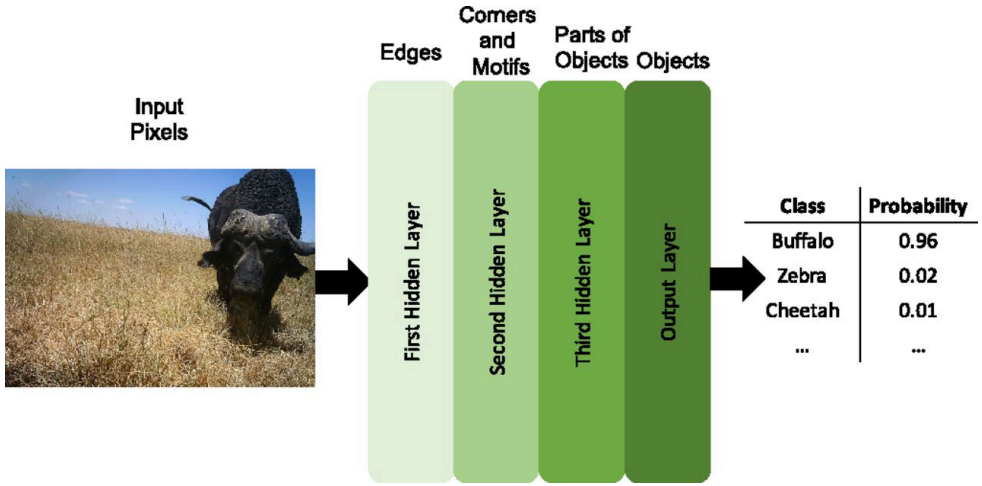


Source: mila

Societal impacts

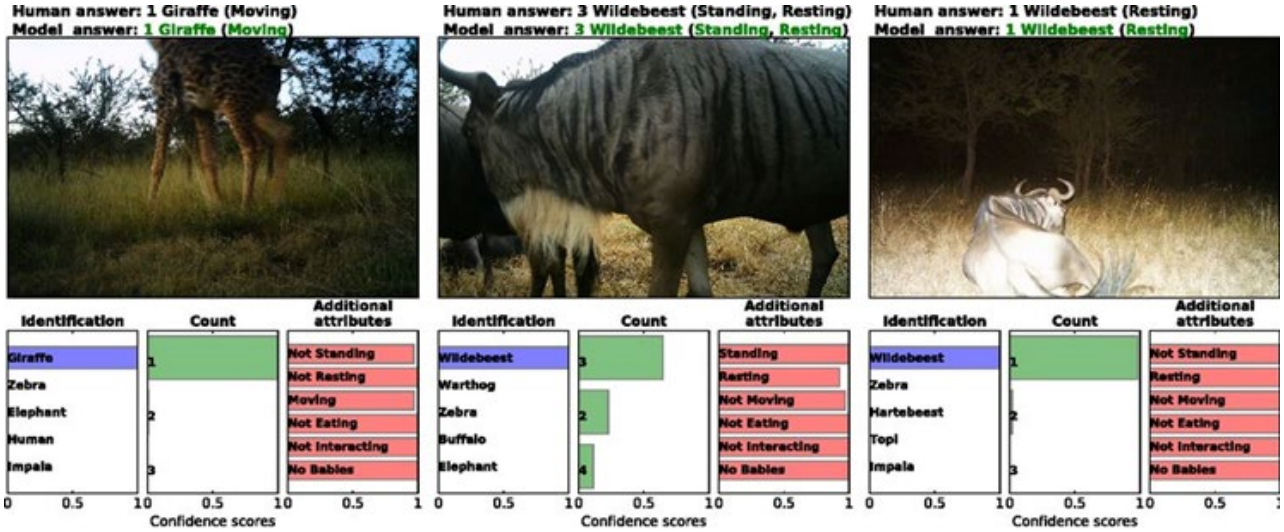
Rolnick, David, et al. "Tackling Climate Change with Machine Learning." *arXiv preprint arXiv:1906.05433* (2019).



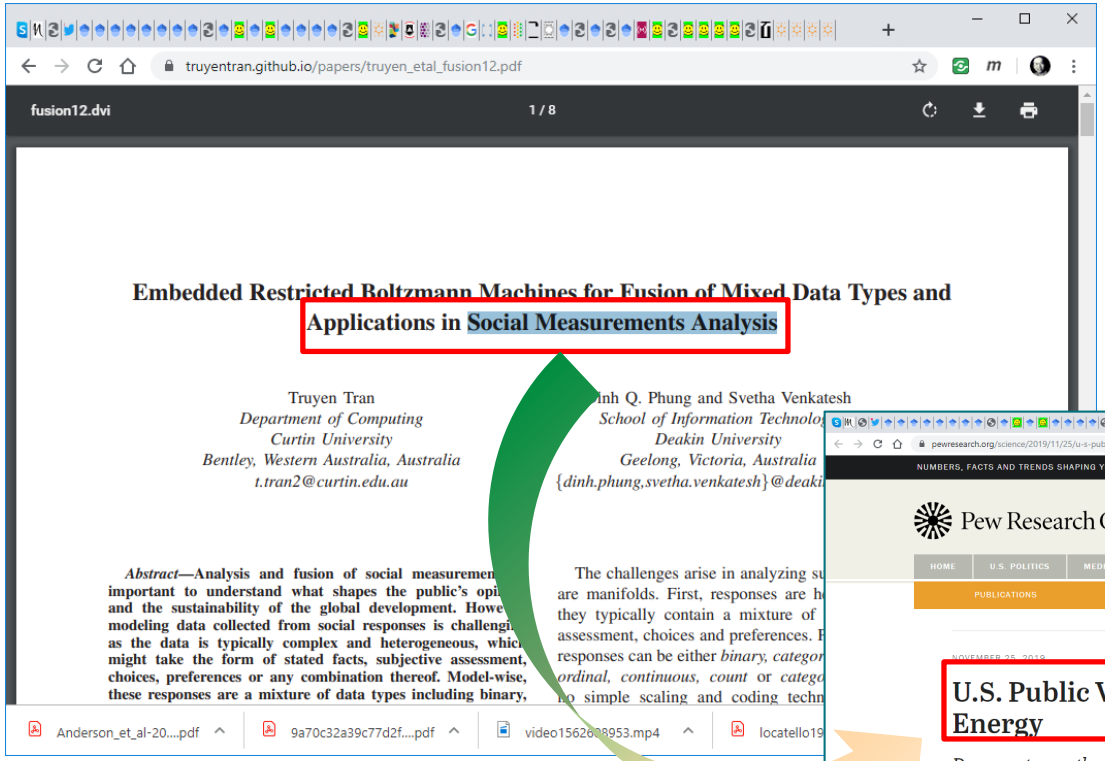


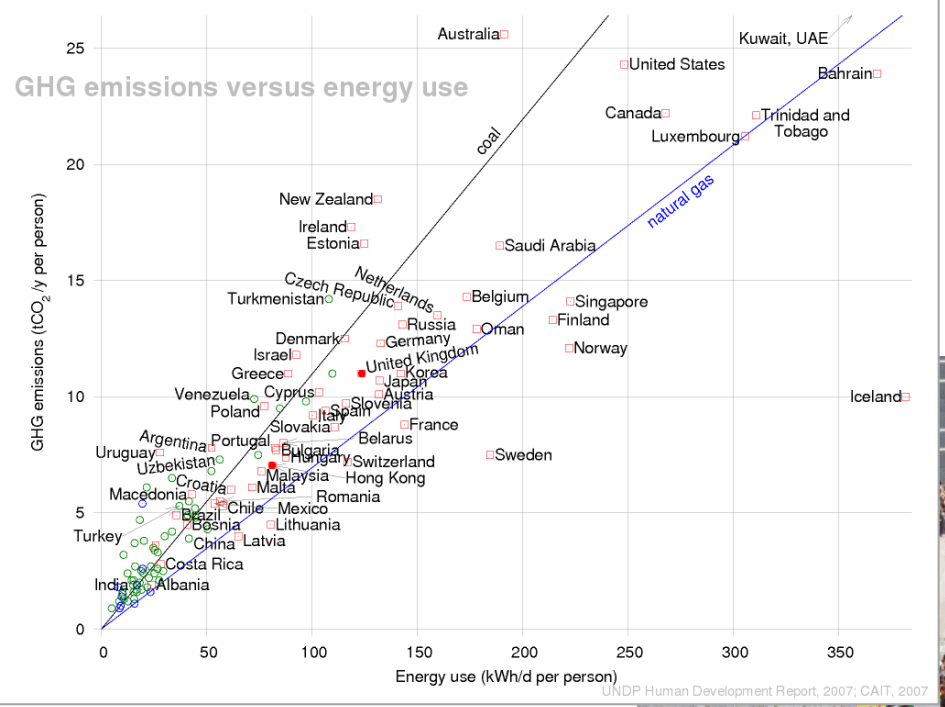
Conservation effort

Norouzzadeh, Mohammad Sadegh, et al. "Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning." *Proceedings of the National Academy of Sciences* 115.25 (2018): E5716-E5725.



AI for social measurements analysis on climate





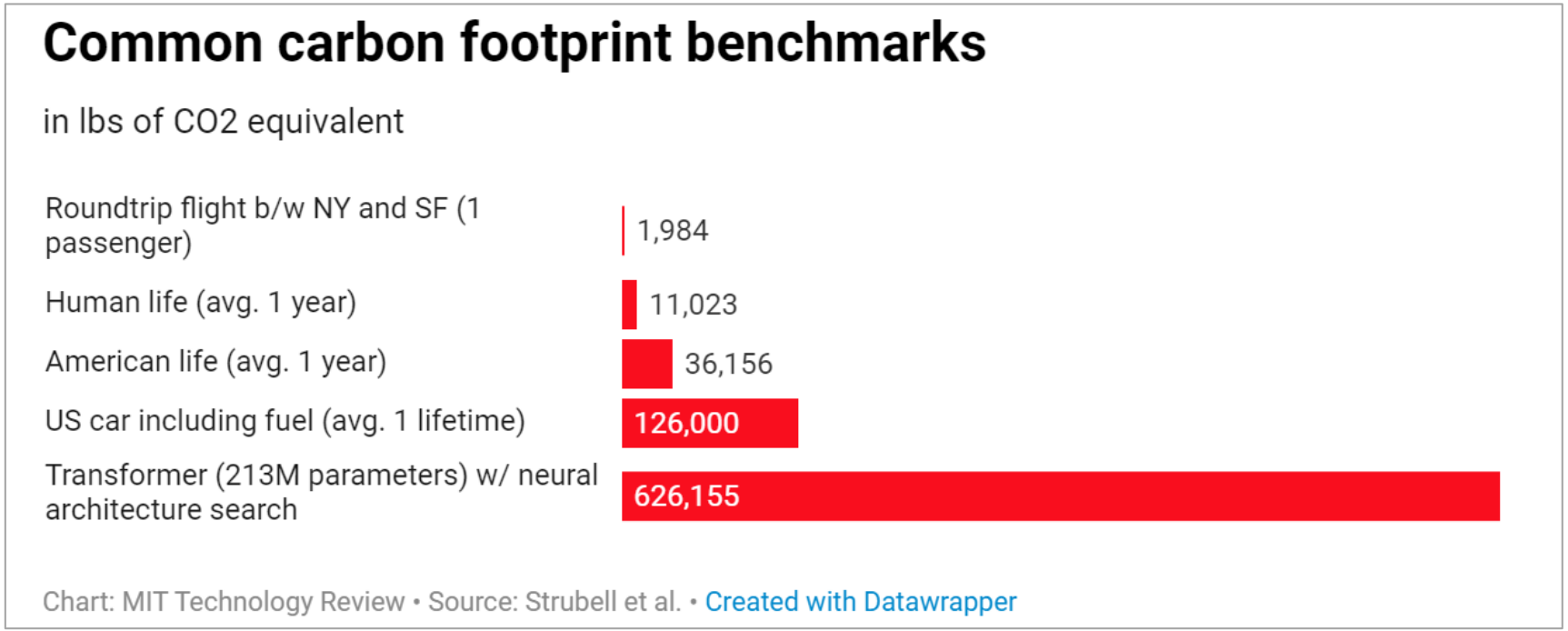
Source: David MacKay, 2007

Education and collective decisions

Individual actions

Source: financial-news-now

Towards green AI



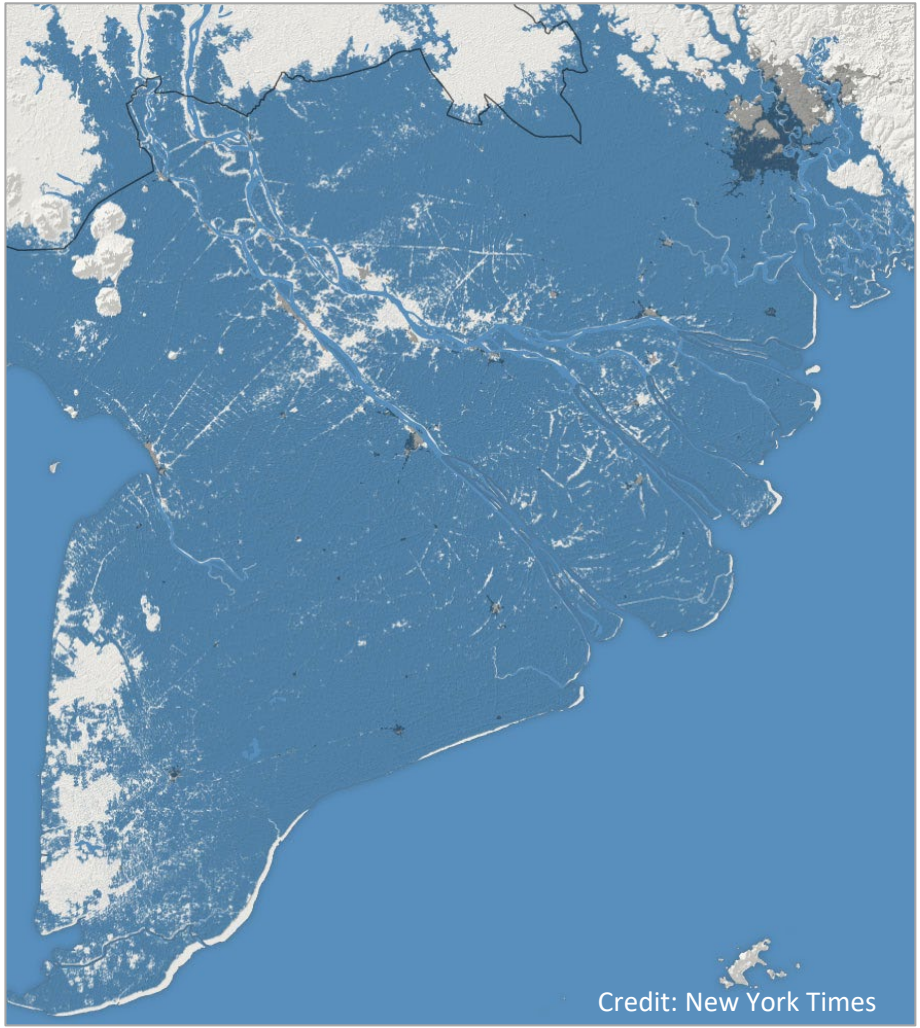
Strubell, Emma, Ananya Ganesh, and Andrew McCallum. "Energy and Policy Considerations for Deep Learning in NLP." *arXiv preprint arXiv:1906.02243* (2019).

South Vietnam, 2050

Prediction model: Neural network

- 23 input features
- trained on US LIDAR-derived elevation data
- Extrapolated over time and space.

However, it has been criticized for using inaccurate data for Vietnam.

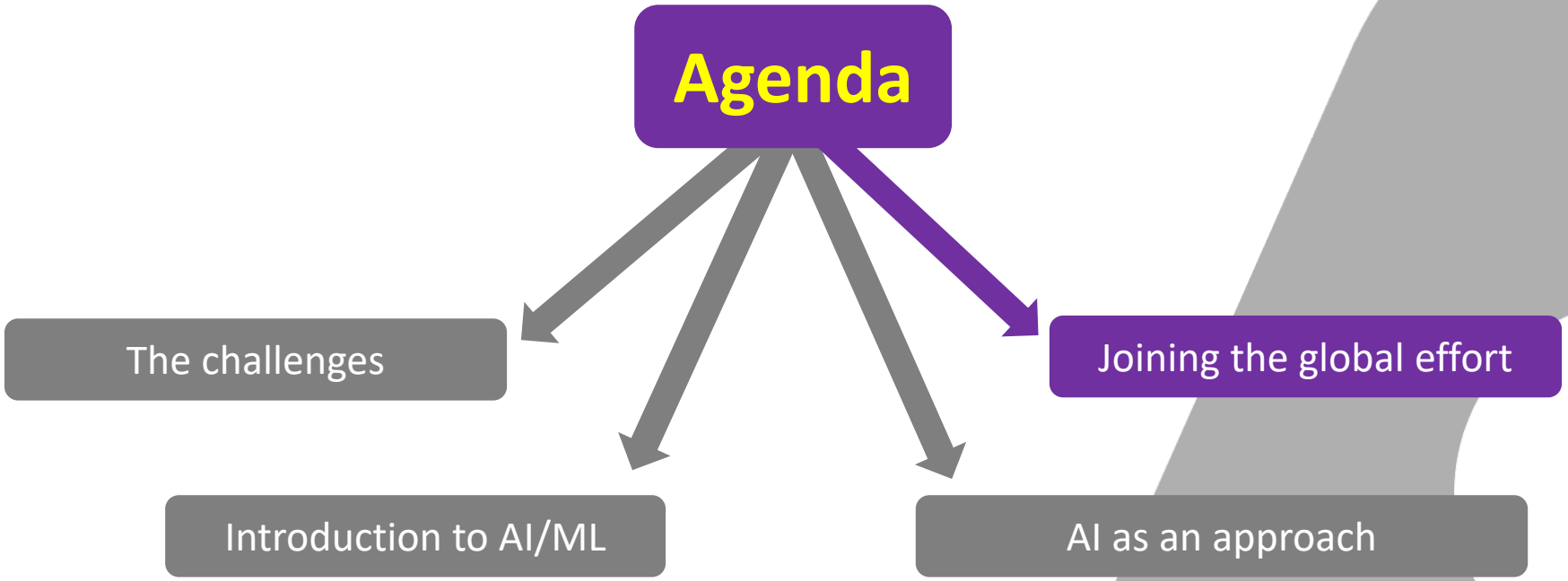


Kulp, Scott A., and Benjamin H. Strauss. "New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding." *Nature communications* 10.1 (2019): 1-12.

Jevon paradox in action

(1835-1882)
Source: Wiki

Source: Pacific Standard & Iconfinder


Agenda
The challenges
Introduction to AI/ML
AI as an approach
Joining the global effort

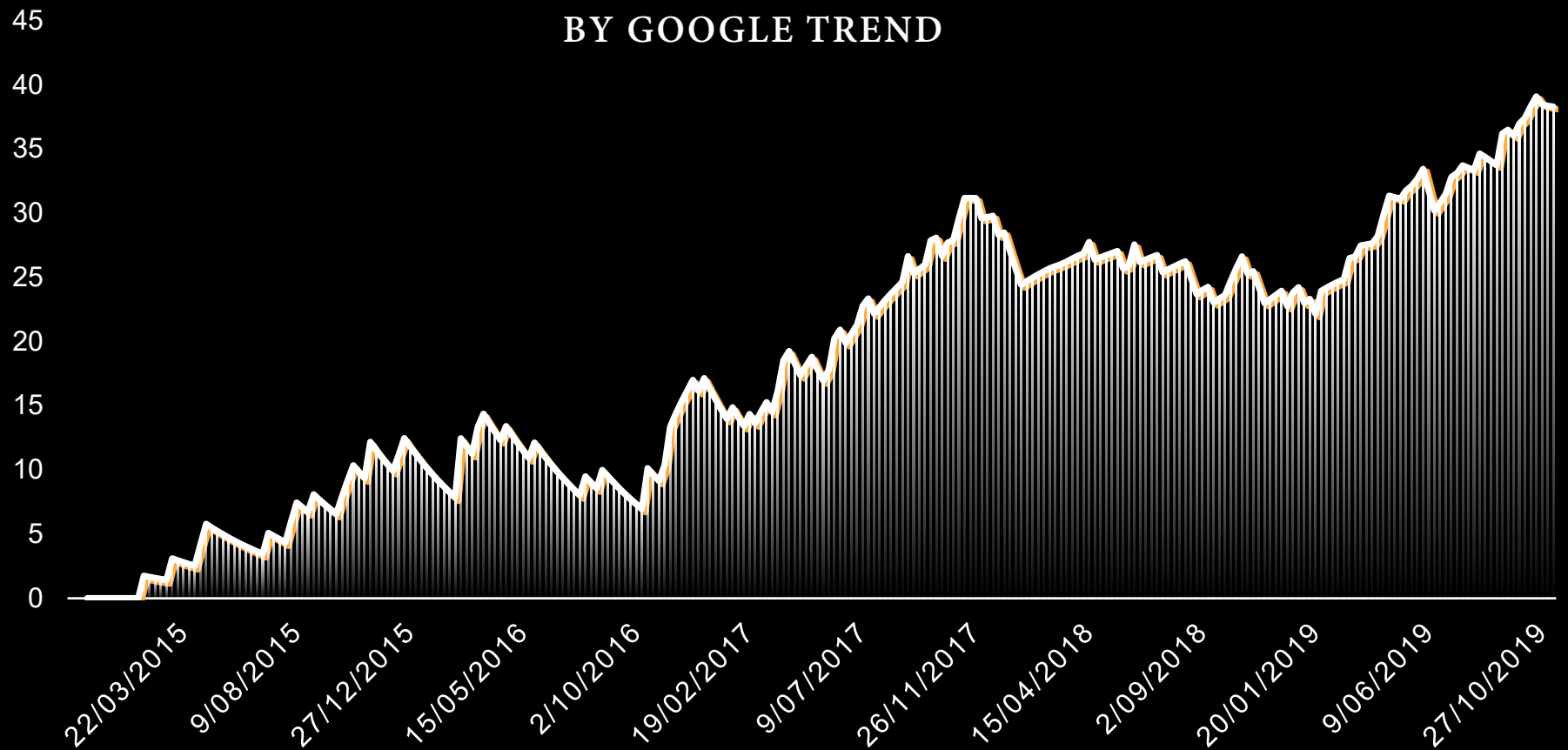
UN sustainable development goals - 2030

Goal 7: Affordable and Clean Energy

Goal 13: Climate Action

AI & CLIMATE CHANGE

BY GOOGLE TREND



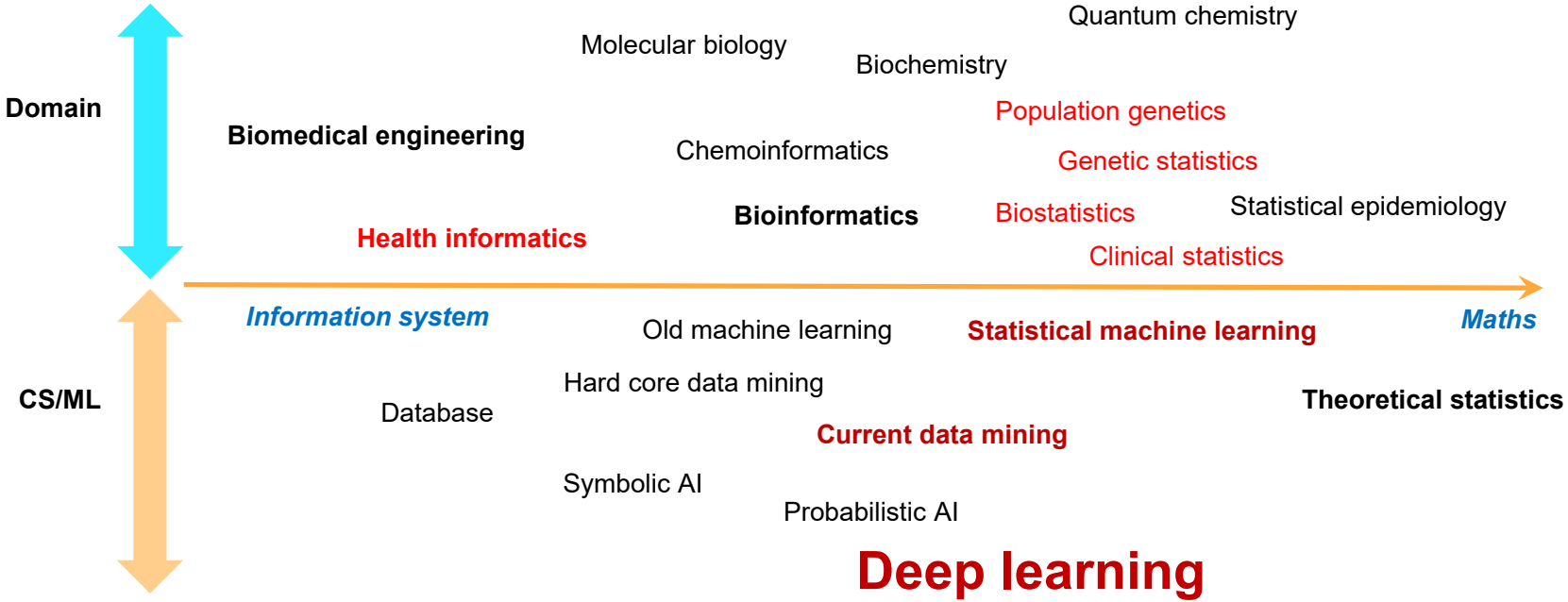
Technology alone is never enough

"Technologies [to help fight climate change] have largely not been adopted at scale by society. While we hope that ML will be useful in reducing the costs associated with climate action, **humanity also must decide to act.**"

Rolnick, David, et al. "Tackling Climate Change with Machine Learning." arXiv preprint arXiv:1906.05433 (2019).

First thing first: Speak collaborators' languages

(The case of biomedicine)



Get Involved

Want to get involved in tackling climate change with machine learning? Check out our recommendations below.

Learn more

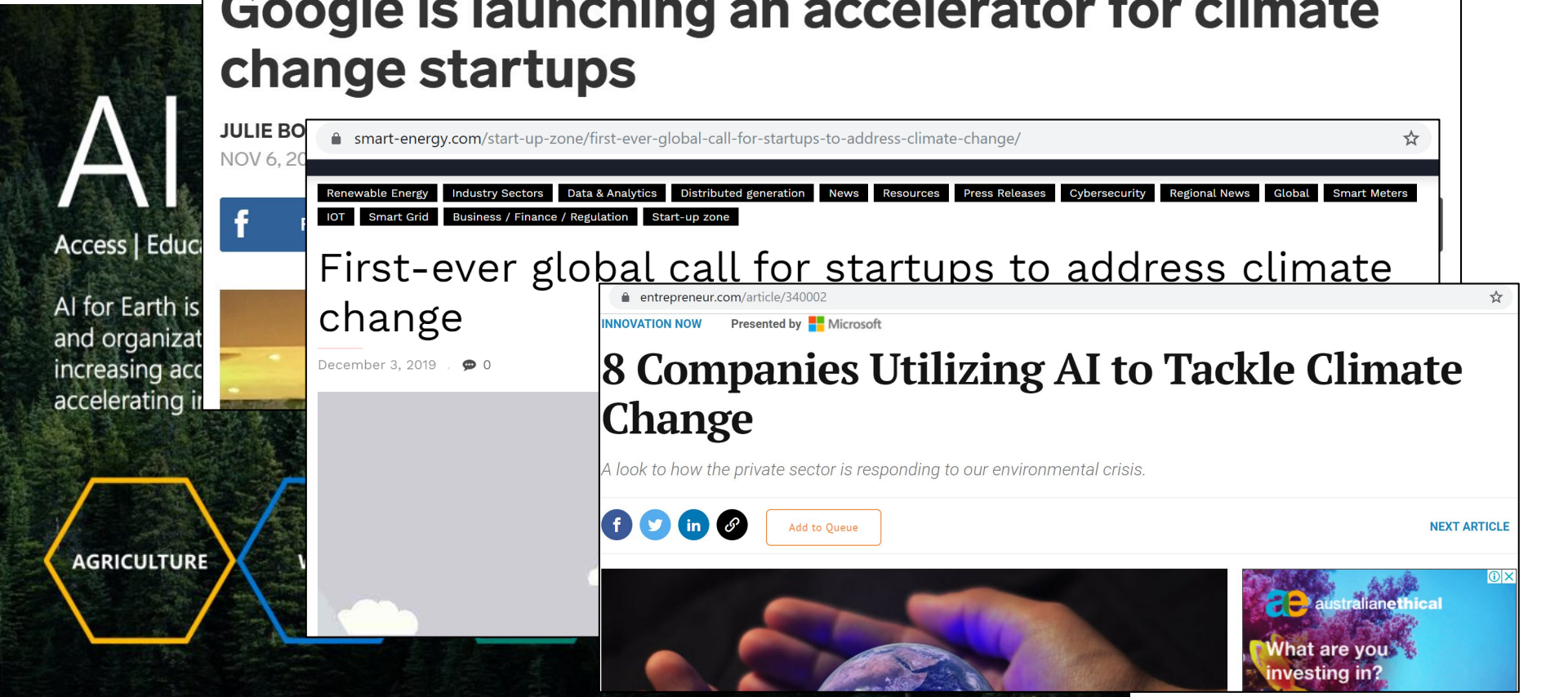
- Read our paper and/or the interactive summary.
- Check out our resources page for background materials and datasets to explore.
- Start a reading group at your institution.

Engage with the community

- Sign up for our newsletter.
- Join our discussion forum to ask questions, share ideas/resources, and build teams.
- Attend one of our workshops (in person or via livestream).
- Organize a meetup in your own location via the discussion forum.

Work on projects

- Organize a hackathon within your organization to brainstorm/jumpstart ideas.
- Find team members who complement your expertise on an impactful problem.



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Google is launching an accelerator for climate change startups

JULIE BO
NOV 6, 2

smart-energy.com/start-up-zone/first-ever-global-call-for-startups-to-address-climate-change/

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First-ever global call for startups to address climate change

December 3, 2019 . 0

entrepreneur.com/article/340002

INNOVATION NOW Presented by Microsoft

8 Companies Utilizing AI to Tackle Climate Change

A look to how the private sector is responding to our environmental crisis.

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To sum up

AI is a General-Purpose Technology (GPT)

- Just like electricity

Why AI for climate change?

- Automation, scalability, knowledge and data integration
- Assisting in decision making
- Rational in an irrational world of politics.
- AI should be a green exemplar

Can AI fail?

- Yes. We are still learning.
- It is subject to misuse.
- It can be wrongly aligned with human values.

Source: opgal

Sir David MacKay

(1967-2016)

Sustainable energy scientist
Cancer fighter

4.1 mil tones of CO2 has been emitted

since I started talking

This talk may have been written by AI

with non-zero probability

It have been delivered by human

with probability 1

.

Thank you

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letdataspeak.blogspot.com

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